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Popular Mechanics

ICE DREAM
PARCHED? JUST FETCH
YOURSELF AN ICEBERG

How to mine an **ASTEROID**

- CLAIM A SUITABLE ROCK
- EXTRACT PRECIOUS MINERALS
- BUILD YOUR SPACE COLONY

WHAT TO DO
WHEN THE EARTH MOVES

DIY

- + GET THE BEST FROM 3D TV
- + 20 WAYS TO BETTER PICTURES
- + GO IT ALONE (IN A CANOE)
- + PROTECT YOUR DIGITAL DATA



< **ROCKET
SCIENCE:**
WHAT GOES UP...
PM TAKES WING
IN A PARAMOTOR >



< **NEW FACE OF
WIND ENERGY?**
**MEET THE
ECO-PERCH >**





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SOMEWHERE OUT THERE

It sounds like something from the fevered imagination of a movie scriptwriter, but the well-heeled backers of a newly established company called Planetary Resources are quite serious: they expect to mine asteroids for a handsome profit. As this month's cover story explains, although they don't expect a quick return on their investment, they have every expectation of making the project economically viable over the long term. As co-chairman Eric Anderson puts it, "we have a 100-year view for this industry".

Our story details some of the ways in which suitable asteroids would be located (not easy, considering that these lumps of rock or metal are small, dark and easily obscured by the distorting effect of Earth's atmosphere), analysed and exploited. Yes, but could asteroid mining *really* produce a good return, taking into account the huge costs – not to mention the technological challenges involved in extracting the valuable minerals? Well, it's been estimated that a 24 m-diameter metal asteroid could hold 30 000 tons of extractable metals, including R400 million worth of platinum alone, so perhaps it could.

Still on the subject of exciting opportunities in our future, we're becoming rather excited about our upcoming **FutureTech 2012** conference, which happens in Johannesburg on 25 October. Our presenter line-up includes highly respected scientists, digital tech gurus and a leading expert in cyber-forensics, with more to come. If you'd like a better understanding of the technology that runs our world (and of our occasionally uneasy relationship with it), this is your chance: check out the details on page 77, then visit our Web site at www.popularmechanics.co.za and click on the "FutureTech" button to book your place.

Moving along, we describe an outlandish project – the brainchild of Frenchman Georges Mougin – that entails capturing and towing a large iceberg from its freezing

birthplace to a parched area of the world such as Australia, Peru or even Namibia, where the potable water would change people's lives. "Ice dream" (page 22) tells how a company called Dassault Systèmes applied its formidable computing muscle to the concept, using 3D software to simulate an iceberg tow from Newfoundland to the Canary Islands, with encouraging results. Could Mougin's dream come true? Stranger things have happened.

Finally, a diversion to the Land of Weird. While compiling a feature on wearable tech, deputy editor Anthony Doman received a hot tip (courtesy of PM's Webmaster, Nikky Oosthuizen) about a product that should resonate with cat-lovers everywhere. He duly located a Japanese fashion electronics company that markets a pair of brain-activated fluffy cat ears with unusual properties: they reflect your state of mind. Apparently, an EEG sensor located on the user's head picks up the brain's electrical impulses and the ears are activated accordingly.

Seriously?

Alan Duggan

aland@ramsaymedia.co.za



futuretech2012

TOMORROW'S TECHNOLOGY TODAY ● Popular Mechanics



Page 34



Page 96



Page 22

COMPETITION WINNERS... Details online at www.popularmechanics.co.za



34

On the cover: It takes a village to mock up an asteroid mining scene. We had the body sculpted from fossilised rock, then assembled the mining site with tiny structures from Xmarx (a US company that specialises in scaled resin terrain and buildings for war games). Since the two parts were different in scale, Plamen Petkov photographed them separately. Finally, PM's digital artist, Anthony Verducci, melded the images to create the finished product. **This page:** Could a large chunk of space rock be a source of fabulous mineral riches? Read our cover story, "How to mine an asteroid".



78



88



62

Reserve your seat now for **PM's FutureTech conference** in Johannesburg on 25 October. For details, see page 77. ALSO, submit your entry soon and stand a chance of becoming South Africa's **Inventor of the Year** (big cash prizes are up for grabs in two categories). For details, see page 82.

TECH

- 22 **Ice dream**
Parched? First, locate a suitable iceberg...
- 40 **Reaching for the stars**
Budding rocket scientists blast off
- 58 **Get the best from your 3D TV**
Some stuff you probably need to know
- 84 **How to take better pictures**
Lesson 1: Get to know your camera
- 86 **Digital clinic Q&A**
 - Purloined profile
 - Smartphone wipeout
- 96 **Just wear it**
Slip into wearable tech

SCIENCE

- 14 **Tech watch**
 - Batman's new tilt-rotor ride
 - Of ice creams and brain freeze
 - Special delivery (in space)
- 26 **Stargazing made simple**

You can do it with binoculars
- 48 **Life at the epicentre**

How do you prepare for the unpredictable?

WHEELS

- 66 **Jay Leno's garage**
Long live Saab!
- 68 **New on the block**
 - Bring it on: Citroën C4 Aircross
 - Class act: Hyundai i30
 - Beefed up: VW Amarok
 - Second bite: Nissan Infiniti
- 94 **Economical motoring 101**
Try these fuel-saving strategies
- 102 **Saturday mechanic**
How to replace your car's window glass
- 104 **Car clinic Q&A**
Volt vindicated

OUTSIDE

- 60 **Go it alone**
Take your canoe and get out there
- 78 **Rev it up**
These flyers get their rush from thin air

[HOME](#)

- ## 100 Homeowner's clinic Q&A
- Looking for a really tough chain
 - Cracks: when to start worrying

FEATURES

- 34 **How to mine an asteroid (Cover story)**
Why tech moguls are betting on space prospecting
- 46 **A brief history of fireworks**
Whizz, bang, etc

TESTED

- 88 ● BMW G 650 GS Sertão
● Motorola Razr Maxx

UPGRADE

- Serious laser
- Urban turbine
- Eco-Perch
- Eco-Marathon

PM DIGITAL

- 99
- **Higgs boson:** this video explains it rather well
 - **How to...** subscribe to our RSS feeds
 - **WIN** family tickets to the rAge expo in October
 - **WIN** Parrot Minikit Smarts
 - **WIN** SteriPen Adventurer Opti
 - **WIN** MAGIX video editing software

IN FOCUS

- ## 91 **Playing outdoors**
- New outboard benchmark?
 - Camping pot... made from paper
 - Take your iPhone diving

MONTHLY

- 1 Editor's notes
- 4 Contact us
- 7 Letters
- 10 Time machine
- 28 Great stuff
- 120 Do it your way



WIN

4 DREMEL HAMPERS WORTH R7 746 EACH (SEE PAGE 75)

PM ZONE

YOUNG. CONNECTED. NOW.



GET INTO THE ZONE!

Look out for next month's issue of **POPULAR MECHANICS** and our inaugural PM Zone, a 24-page supplement aimed at **young and inquiring minds**. You'll encounter weird inventions, young scientists, cool gadgets, social media tips, fun projects, amazing bicycles, brain teasers, and a couple of experiments that are guaranteed to annoy your folks. And that's just for starters.



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FOR OUR CURRENT SUBSCRIPTION RATES, SEE PAGE 75

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Could Flight AF447 have been saved?

I read and re-read your chilling account of the last minutes of Flight AF447 (Tech-watch, April 2012). It's difficult to believe that in the era of the A330, with all its advanced technology, human error and (bad) judgment could result in such a crash. Given enough autonomy, would the computers have been able to avoid it? Perhaps the information could have been presented to the pilots differently?

I design medical devices. Any medical device must cater for "foreseeable misuse" – and it's a real challenge to decide how far to go without increasing the hassle factor for the user.

Adding to the challenge is the huge disparity in technical awareness among medical staff, which is a far greater challenge in the field of medical devices than in the aerospace industry – the acknowledged leader in safety in design and issues such as human factors and software. However, we can also translate this into an opportunity: we have many innovators in the field of medical science, and our medical device industry has scope to grow.

BRIAN GOEMANS
CAPE TOWN

Survival skills: my angle

I loved your article on 20 cool ways to open a beer (July issue). Here's another one that I've seen done but never quite succeeded in replicating. You'll need a metal spatula of the kind used to flip eggs: hold the bottle in one hand, with the top pointing away from you, and slide the spatula quickly and firmly along the bottle towards the cap. If you do it hard

MEMORIES OF MEMORY

I remember the day in 1987 when I got my first PC. It was an IBM XT, switchable from 4,77 MHz to 10 MHz – better than the machine owned by the guy next door, which could switch only to 8 MHz. It had 640 k (that's kilobytes!) of RAM, which could be expanded to 1 MB. Oh, and did I mention the DOS 2.2 operating system?

What really stumped my mates was that I had opted for a 20 Mb Seagate hard disc. They were all of the opinion that it was overkill (as in, "How could you possibly have any use for all that memory?"). Let's refer to this original disc as HD1. At the time, most PCs had one or two 360 k floppy disc drives, one of which was used to boot up DOS every time the PC was switched on. A 1,2 Mb floppy disc drive came in due course. I had an amber screen (yellow and black) powered by a Hercules card.

As I sit here, a pop-up on my screen informs me that I'm transferring data to an external hard disc at 20 Mb/s – the equivalent of HD1 every second. On my desk lies a 64 Gb memory stick that accommodates the equivalent of 3 200 HD1s. The 3 Tb external is equivalent to 150 000 HD1s.

What could this XT do in terms of computing power? In one of our assignments (signal processing with Professor Linde), we had to generate 100 000 pseudorandom numbers using the Wichman Hill algorithm and write them to disc. My XT took 74 minutes to run the Pascal code amidst the aroma of instant coffee and pages of code printouts from a dot matrix printer.

This was reduced to 14 minutes after I added a very expensive maths co-processor. On my next PC upgrade, to a 386 with maths co-processor, it took 8 minutes. I lost the code for the assignment somewhere along the way; floppy discs were unreliable and we made our first acquaintance with computer viruses. I am pretty confident that the quadcore i7 processor here on my desk (with 16 Gb of memory) would take the briefest sniff to complete that code now.

Why am I telling you this? Simple: can you imagine what we'll have in 25 years' time? We certainly couldn't in 1987, and we were a bunch of very imaginative students back then. I was just thinking that PM would be a perfect forum for readers to predict the technologies we'll have in 25 years' time.

Thank you, PM, for your excellent contribution to technology awareness.

CECIL GERICKE
HARTENBOS

Write to us, engage us in debate, and you could win a cool prize; this month's best letter wins a Casio G-Shock GA-100 watch worth R1 499. This ruggedly attractive, shock-resistant timepiece features a 1/10 000th-second stop watch, velocity indicator, world time, an auto LED light, and water resistance to 200 metres. For more information, contact 011 314-8888 or visit www.jamesralph.com

Send your letter to: Popular Mechanics, PO Box 180, Howard Place 7450 or e-mail popularmechanics@ramsaymedia.co.za Please keep it short and to the point. Regrettably, prizes can be awarded only to South African residents.

and accurately, the edge of the spatula will catch the cap's crown and pop it off. However, if the spatula catches the glass just below the cap, it will pop off the neck instead. I'm still trying to get it right!

JAIME LOPES
VIA E-MAIL

Editor's note: "This sounds vaguely similar

to the trick used by exponents of sabrage, most notably (in South Africa, anyway) Haute Cabrière's Achim von Arnim, who wields a sabre to magnificent effect as he slices the upper neck from a bottle of champagne or sparkling wine. Having attempted this ourselves, we're able to confirm that it's not for the faint-hearted.

Gloves off?

I really enjoy POPULAR MECHANICS, having received a subscription to the magazine as a gift. In your article, "20 ways to open a beer bottle", the writer proposes using a ring to remove the bottle lid. This is not recommended as there is the possibility of degloving one's finger should something go wrong (see attached photograph). Having said that, I do appreciate the need to open a cold beer and will go to great lengths if there is no bottle opener around. Thanks for the interesting read.

MIKE BLACK
VIA E-MAIL

Editor's note: The accompanying image was far too gory to publish. Point taken.

Printing singularity

Will affordable 3D printers represent a "singularity" for model engineering? My excitement is not focused on the ease of making things, but more on the possibilities for collaboration and refinement. I've noticed that 3D printers using ABS plastic are now on sale for about \$1 500 (R12 000). The price is still a bit steep for my engineer's salary, but well within the means of many clubs.

These units typically boast an accuracy of 0,2 mm at 30 per cent strength of injection parts – possibly an issue for smaller-scale modelling? Some of the more conservative modellers out there may feel that it will subtract from the "art" of traditional model-building. Far from it!

Think what computers did for graphic design and the movies... they gave people much more freedom to let their imagination go wild.

I predict that you will soon find people sharing 3D printing files derived from actual drawings of products they are working on. Translating these drawings will be a new art form in itself (taking into account the printer and material limitations), making the opportunity for incremental refinement via collaboration between people all over the globe a reality. The last time I was this excited about a product was way back in my high school days, when the post office delivered my Sinclair ZX81 kit.

JAN MARAIS (B.ENG, PR.ENG)
CAPE TOWN



Alternative energy? A Rover SD1 equipped with an Imbert converter.

Powered by... wood chips?

With so much attention being focused on alternative fuels, you might be interested in this edited extract from my recently published book, *Is Chernobyl Dead?* (available from EE Publishers; admin@ee.co.za): "What do you do when, suddenly, practically no petrol is available and you somehow have to keep cars, lorries, engines, ships and tractors running? This was the situation that many countries found themselves in soon after the outbreak of World War II, in 1940.

"While alcohol for fuel was no longer available in large quantities, wood was. And when petrol supplies disappeared in 1940, older people remembered what they had used before petrol: wood gas, made from wood chips in a far smaller bin heated by charcoal during World War II, in what was known as an Imbert gasifier.

"The main gases formed – carbon monoxide and hydrogen – burn reasonably well in both petrol and diesel engines, forming carbon dioxide and water. Called synthesis gas, this mixture is also produced on a huge scale today by heating coal, and used to form a variety of hydrocarbons, including octane, at Sasol's oil-from-coal plants.

"But the Imbert gasifier was far simpler and was mass-produced during World War II by many European automotive companies, including General Motors, Ford and Mercedes-Benz. However, it had disadvantages. Besides having somewhat low efficiency, operating it meant shovelling in chunks of wood chips, and lighting all this by means of charcoal. Also, danger was never very far away: the gasifiers produce carbon monoxide, an extremely poisonous gas, and sometimes exploded.

"Small wonder, then, that once petrol again became available in 1946, the use of these generators was quickly discontinued. Ironically, we may yet see these generators again in the future, albeit in a different form. More recently, a process very similar to the old Imbert gasifier has been used to run a car on coffee grounds."

CHRIS MEYER
VIA E-MAIL



Many happy returns!

A friend in your company has just shown me an advance copy of your 10th birthday issue (my own copy is due later this week). It's a great magazine and your team deserves hearty congratulations for delivering a decade of amazing articles. We look forward to more of the same for the next 10 years and more.

ELIZABETH CILLIERS, CAPE TOWN

Dodgy sums dept

We must concede a teensy addition error in the introduction to our story on stand-out PM covers from the past 10 years ("Lifting the covers", August issue). In fact, that issue was the 121st to be published since our launch in 2002, and our stated total of editorial pages was out by a factor of ten. Aside from these, our calculations were spot on. No, really. PM

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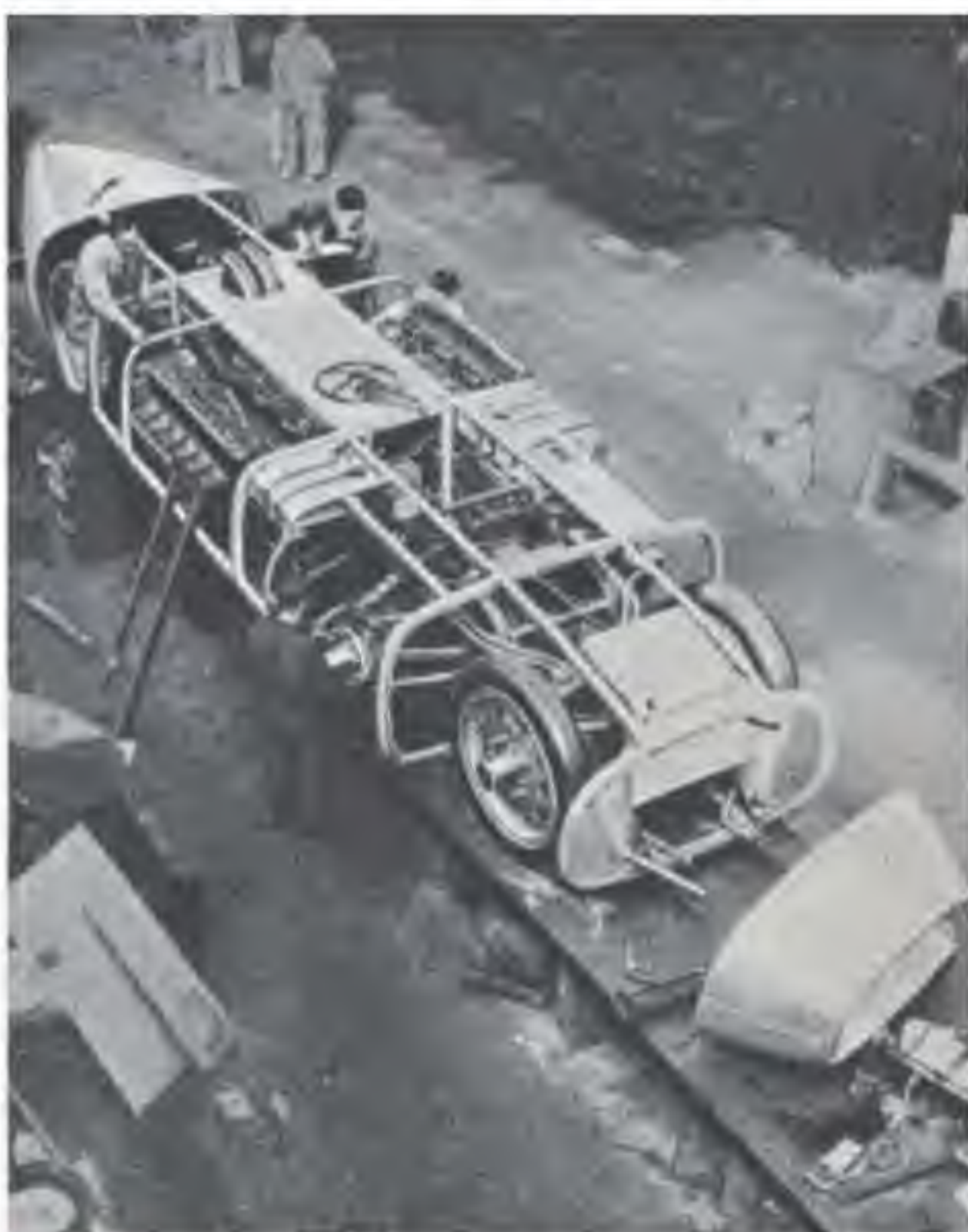
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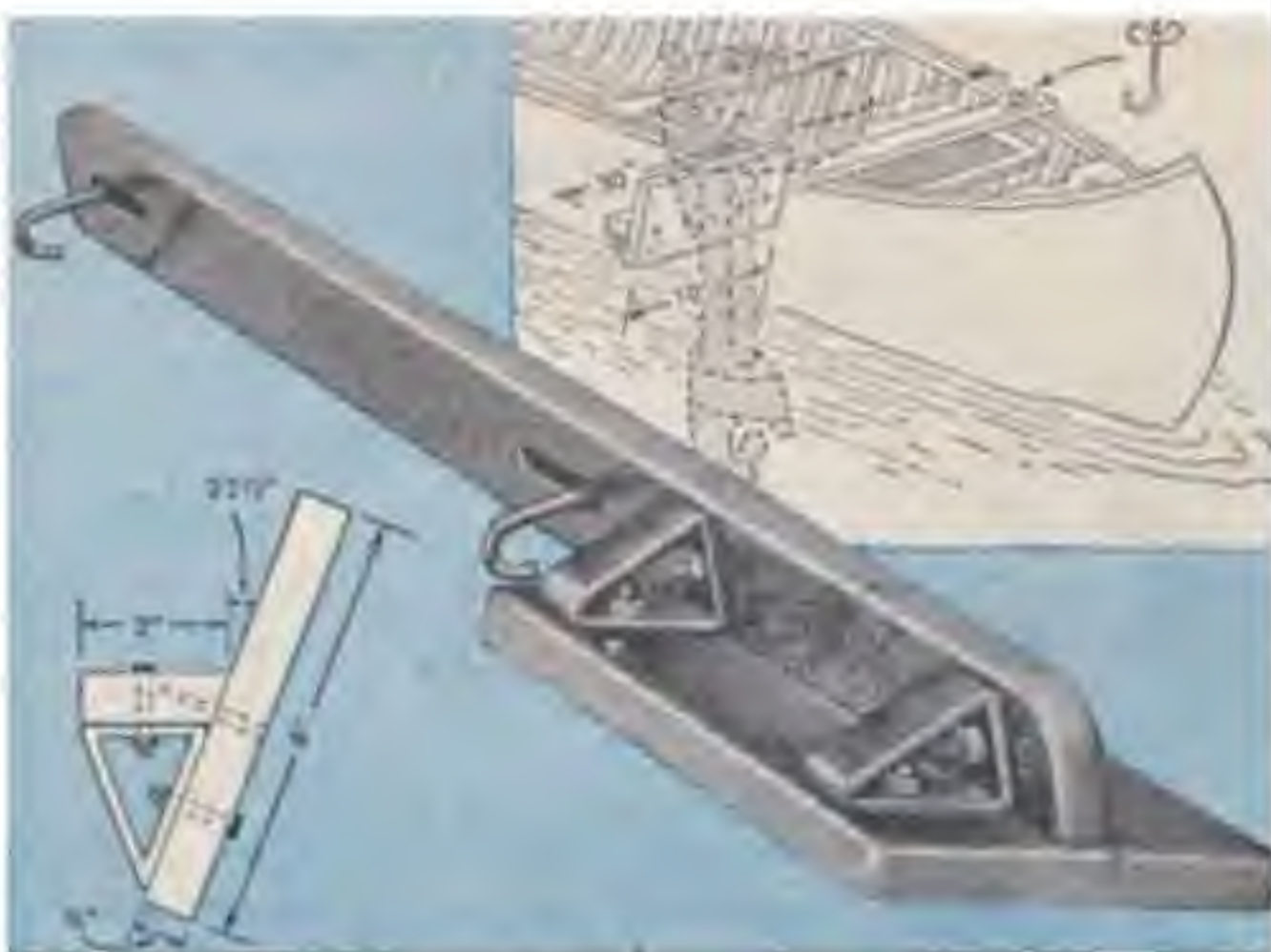
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**Commercial
Vehicles**



1939 An article by Captain George Eyston, who had established a new World Land Speed Record of 357,5 miles per hour (about 575 km/h) the previous year in his *Thunderbolt* streamliner, ventured the opinion that "man would probably never travel much faster on earth". It was a little premature, of course: John Cobb (*Railton Mobile Special*) broke the record a year later, and the current record is held by Britain's jet-powered *Thrust SSC* at 1 227,986 km/h (that is, faster than sound at sea level).



1948 This disarmingly simple device was actually quite useful because it provided a way of attaching a lightweight outboard motor – a modern application might employ an electric trolling motor – to a canoe in such a way that it permitted full tilting and steering control. Note to DIY types: please come up with your own design and tell us about it.

Owners' Reports: DODGE, OLDSMOBILE

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And How to Prevent It

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To Easy
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Fast-Growing Tabletop Gardens



1965 Although this month's cover story focused on an affordable DIY powerboat, the real gem was a primer on negotiating big-city traffic, drawing on the experience of seasoned New York cab drivers who had learned how to avoid distracted or slow-moving drivers. Confided one expert: "You can peg a driver just by watching him (for) a couple of minutes. Is he sure of himself? Does he look alert? Or is he busy gabbing with his wife or watching the curvy blonde across the street?" Sigh. Nothing changes.



1940 In an inspired initiative aimed at making British police officers easily visible in the blackout (remember, Britain was at war with Germany), someone came up with the idea of equipping them with white coats, stop-and-go lamps, and illuminated signs on their helmets bearing the word "police". This policeman's vague resemblance to Beatle Paul McCartney is irrelevant, by the way. PM

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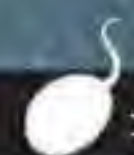


TECH WATCH

TECH CULTURE

Batman's new ride

Work on Christopher Nolan's Batman movies always starts with the superhero's vehicle. For *The Dark Knight Rises*, production designer Nathan Crowley incorporated features from military aircraft – including tilt-rotors and jump jets – to create the Bat. The pitch of the rotors under the frame enables the Bat to move forward, and it hovers by venting jump-jet exhaust through its body. "We had to push ourselves to make something that was very believable," Crowley says. Special effects supervisor Chris Corbould constructed two Bats and built rigs (erased in post) to make it look like they were flying.



> Visit www.popularmechnics.co.za to find out more about the Bat.

F-35B

"If you have enough power, you can make almost anything fly."

– MIKE SKAFF,
LOCKHEED MARTIN
ENGINEER



John Wilson

Could it really take off?

The Bat is inspired by Lockheed Martin's short-takeoff and vertical-landing warplane, the F-35B. The Bat's ducted fans, mounted on arms, swivel down to hover, similar to the way the

F-35B's engine nozzle changes orientation.

Mike Skaff, chief engineer for F-35 pilot-vehicle interface, says the Bat's multiple flight-control surfaces and ducted fans are not that

far-fetched. "There's a lot of Hollywood in it," Skaff says. "But that's not to say that we can't (invent tech that will) levitate such a vehicle."

– ERIN MCCARTHY





GROOVES FUNNEL WIND TO INCREASE ITS SPEED

TURBINES SPIN TO GENERATE POWER

Squeeze play

No disrespect to veteran baseballer Shin-Soo Choo, but the Cleveland Indians decided they needed more power in right field. Working with engineers at Cleveland State University, Progressive Field's owners installed a corkscrew-shaped structure in the stadium housing four mini turbines that are expected to generate 25 000 kilowatt-hours of electricity per year. The design funnels wind into the turbines, allowing them to generate power on even relatively calm days. This will augment energy from solar panels installed at the stadium in 2007.

— ALEX HUTCHINSON

BLACK MARKET

One million counterfeit parts from China were found in US military hardware by Senate Armed Services Committee investigators. "Counterfeiters are becoming better at shielding their dangerous fakes from detection," says Senator John McCain, the committee's ranking member.

NEWS BRIEF /

Brain freeze basics

MYSTERY: What causes the brief, flaring headaches that plague ice cream eaters?

METHODOLOGY: Researchers working with the US Department of Veterans Affairs, seeking ways to treat headaches caused by explosions, used ice water to trigger headaches in 13 volunteers. The researchers monitored the blood flow to the brain using transcranial Doppler imaging.

EXPLANATION: Pain started when the anterior cerebral artery dilated and sent a rush of blood to the brain, presumably in an attempt to keep it warm. Soon after, the artery constricted once again, relieving the pain by allowing the pressure in the brain to drop. The researchers speculate that other, more serious types of head pain, such as migraines, could be triggered by a similar mechanism; if so, drugs that alter the brain's blood flow could offer new treatments. — AH



Special delivery

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WHY IT MATTERS

SpaceX became the first private company to design and launch a craft carrying cargo to the ISS. The cost savings over government programmes may open space to a variety of commercial ventures.

THE LAUNCH

The Falcon 9 rocket rolls on to the launchpad at Cape Canaveral Air Force Station in Florida. Nasa monitors the flight from launch centre in Houston and Florida; SpaceX employees from their headquarters in California.



3:53 am

The Dragon separates from the rocket's second stage; minutes later the spacecraft's solar arrays deploy (above).

3:47 am

First stage separation.

3:45 am

"Vehicle is supersonic."

— SPACEX MISSION CONTROL, HAWTHORNE, CALIFORNIA.



May 22 3:44 am ET

Falcon 9 launches from Cape Canaveral with a thrust of 1,5 million joules.

GLOSSARY



KEEP-OUT SPHERE A 200-metre-diameter circle around the International Space Station where spacecraft access is tightly controlled to avoid collisions with the station.



17,6-METRE ROBOTIC ARM

THE RENDEZVOUS

May 24

After firing its thrusters to catch up with the ISS in co-elliptical orbit, the Dragon performs tests to prove it can manoeuvre reliably, then closes the gap to 2,4 kilometres. The two craft are moving at about 30 000 km/h.

May 25 9:45 am

Dragon crosses the keep-out sphere and halts in free drift 10 metres from the ISS. A LIDAR sensor is not working; Nasa's mission control reminds the ISS crew that if the other fails, the mission will abort.

9:47 am

"The crew is ready for Dragon capture." – ISS CREW MEMBER ANDRÉ KUIPERS

9:56 am

ISS crew member Don Pettit hooks into a port on the capsule with a robotic arm. "It looks like we've got us a dragon by the tail," he says. Applause erupts in Nasa's command centre in Houston and SpaceX's mission control in Hawthorne.

12:02 pm

After using remote video cameras and binoculars to confirm that the capsule's seals are free of debris, the ISS crew connects Dragon with the Harmony module.

May 26 5:52 am

"You have a 'go' for ingressing Dragon." – NASA MISSION CONTROL

5:53 am

Pettit and Kuipers, wearing respirators, open Dragon's hatch. The air inside is free of launch fumes. Pettit later says it "smells like a brand-new car".

THE RETURN

Unlike automated cargo craft built by Russia, Japan, and Europe, which burn up during re-entry, the Dragon can safely descend to Earth. And unlike Russia's manned Soyuz capsule, it can carry substantial cargo on the return trip.

May 31 5:49 am

Dragon, filled with completed experiments and 620 kilograms of unwanted gear, pushes away from the robotic arm with three departure burns.

11:08 am

Dragon jettisons its trunk and solar panels. Within 10 minutes, friction from the atmosphere begins to raise the heatshield's temperature to 1 600 degrees.

11:26 am

Hot plasma blocks communication with the capsule as it burns through Earth's atmosphere.

11:35 am

Two drogue chutes deploy at 14 000 metres to stabilise and slow the spacecraft. These detach when three 35-metre-diameter main parachutes open at 3 000 metres.

11:42 am

The capsule splashes down in the Pacific, about 800 kilometres off the coast of Baja California. A dive team dispatched from a 55-metre barge secures the capsule; a crane lifts it to the barge's deck.



"This mission heralds the dawn of a new era of space exploration, one in which there is a significant commercial space element."

– ELON MUSK, FOUNDER, SPACEX

NEWS BRIEF / *Programmed muscle*



Heart attack survivors are often left with scar tissue that hinders the organ's ability to pump blood, leading to problems as serious as heart failure. Scientists at Duke University Medical Centre in North Carolina, USA, are "reprogramming" that scar tissue into new heart muscle, using microRNA molecules that control gene activity in the individual cells. The new technique has been successfully demonstrated in a living mouse and may turn out to be more practical than competing approaches using stem cells. The next step is to try it in larger animals; it could take up to a decade to reach human trials. – ALEX HUTCHINSON



FLIGHT DYNAMICS

Paper of record

Building a 360-kilogram paper aircraft is tough – but getting it airborne is even tougher, as a team led by the Pima Air and Space Museum in Arizona found out. After several false starts, including the plane buckling under its own weight, a helicopter managed to hoist the plane by its nose and then release it. The result: a glorious flight with a very, very hard desert landing. The remains of the plane – small fragments of the nose and one of the winglets – are now on display at the museum. – AH



> Visit www.popularmechanics.co.za to view the complete flight (and spectacular crash) of a great paper aircraft.

Stats

Length: 13,7 metres
Wingspan: 7,3 metres
Altitude: 824 metres
Top speed: 158 km/h
Free flight: 1,5 km
Landing: hard



NEWS BRIEF / *Tunnel vision*

Water flows from as far as 200 km away to reach New York City from upstate reservoirs, but it needs virtually no pumping because the pipes run downhill the whole way. In fact, New York's and many other urban water systems deploy pressure-reducing valves to dissipate excess pressure before the water reaches the taps of consumers. A startup called Rentricity proposes adding small turbines near those valves to generate electricity; a plan currently being studied by New York City. Rentricity turbines at a gravity-fed water treatment plant in Keene, New Hampshire, now generate 62 kilowatts, enough to run the entire plant. New York may be a tougher sell, because real estate – aboveground and belowground – is highly congested. The feasibility report is due by the end of 2013. – AH

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[illegible]

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Don't take on this crustacean. The force created by the mantis shrimp's club is more than 1 000 times its own weight. It's so powerful that Kisailus needs to keep it in a special aquarium in his lab so it doesn't break the glass.



UNDERSEA BRAWLER

You looking at me?

They say dynamite comes in small packages...

Meet the mantis shrimp – a small, apparently harmless crustacean that resembles an armoured caterpillar and lurks in tropical waters. In reality, this creature is a real bruiser, and a heavily armed one at that. The 10 cm-long shrimp is equipped with a bright orange fist-like club that accelerates under water faster than a .22-calibre bullet. Repeated blows can destroy mollusc shells and crab exoskeletons, both of which have been studied for decades for their impact-resistant qualities.

A team of researchers at the University of California at Riverside Bourns College of Engineering believe military body armour and vehicle and even aircraft frames could be transformed by incorporating the unique structure of the shrimp's club, a highly complex weapon consisting of three specialised regions that work together to create a structure tougher than many engineered ceramics.

The first region, located at the impacting surface of the club, contains a high

concentration of mineral, similar to that found in human bone, which supports the impact when the mantis shrimp strikes prey. Further inside, highly organised and rotated layers of chitin (a complex sugar) fibres dispersed in mineral act as a shock absorber, absorbing energy as stress waves pass through the club. Finally, the club is encapsulated on its sides by oriented chitin fibres, which wrap around the club and keep it intact during these high-velocity impacts.

And that's not all. The acceleration of the club creates cavitation, meaning that it shears the water, literally boiling it and forming cavitation bubbles that implode, yielding a secondary impact on the mantis shrimp's prey.

Researcher David Kisailus and his collaborators are focusing primarily on improving military body armour, which can add 13 kg to a soldier's load. Their goal is to develop a material that is one-third the weight and thickness of existing body armour. **PM**



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Go Further

Although it sounds like the stuff of 21st century techno-fantasy, the idea of towing icebergs from their polar home to the shores of countries desperate for potable water actually goes back at least half a century. Now, a reputable company has devoted its formidable computing muscle to the concept – with encouraging results.



ICE DREAM



Potable water is a rare resource in many countries. In the 21st century, nearly a billion people around the world still do not have access to clean water, while more than 2,5 billion more live in areas with no water treatment system. While researchers across the world search for solutions, a very small number are turning their minds to gigantic reservoirs of fresh water that have yet to be exploited: icebergs.

Unlike floe ices, which consist of frozen seawater and often accommodate wild animals such as seals and polar bears, icebergs are drifting mountains of fresh water. Calved from polar glaciers and continental icecaps, they drift in the ocean until they melt. Each year, tens of thousands of icebergs are produced from glaciers in this way – all of them destined to succumb without trace. And each year, the equivalent of a year's consumption of potable water melts and disappears.

The idea of exploiting icebergs to produce fresh water goes back at least to the 1950s, with research projects by the US Army. It gained momentum in the 1970s, notably under the influence of the famous French polar explorer, Paul-Emile Victor, his friend (and Arts et Métiers engineer) Georges Mougin, and a Saudi prince

named Mohamed al-Faisal. The first international convention on the use of icebergs, held in Iowa in 1977, was attended by 200 people, including respected engineers, scientists, military personnel, officials and journalists.

But the technical obstacles were both complex and formidable; experimentation required astronomical budgets, and the relevant technologies did not yet exist. In the ensuing years, the excitement died down and scientists turned towards more realistic, less controversial and less costly projects.

Outrageous, certainly. But possible?

At the time, the idea of towing an iceberg seemed outrageous. But in the last 40 years, there has been considerable technical progress, and our knowledge of icebergs has greatly improved. Could Georges Mougin's project be reborn? For much of his life, Mougin had honed his theories on capturing and towing tabular icebergs. He studied the best way to slow their melting and pursued a radical invention – a 12 m-high floating "skirt" made from synthetic textile – that would make it possible for a single, powerful tugboat to tow the iceberg, using following currents to maximum effect.

Possible destinations? Depending on such factors as prevailing winds and currents and Earth's rotation, these might include

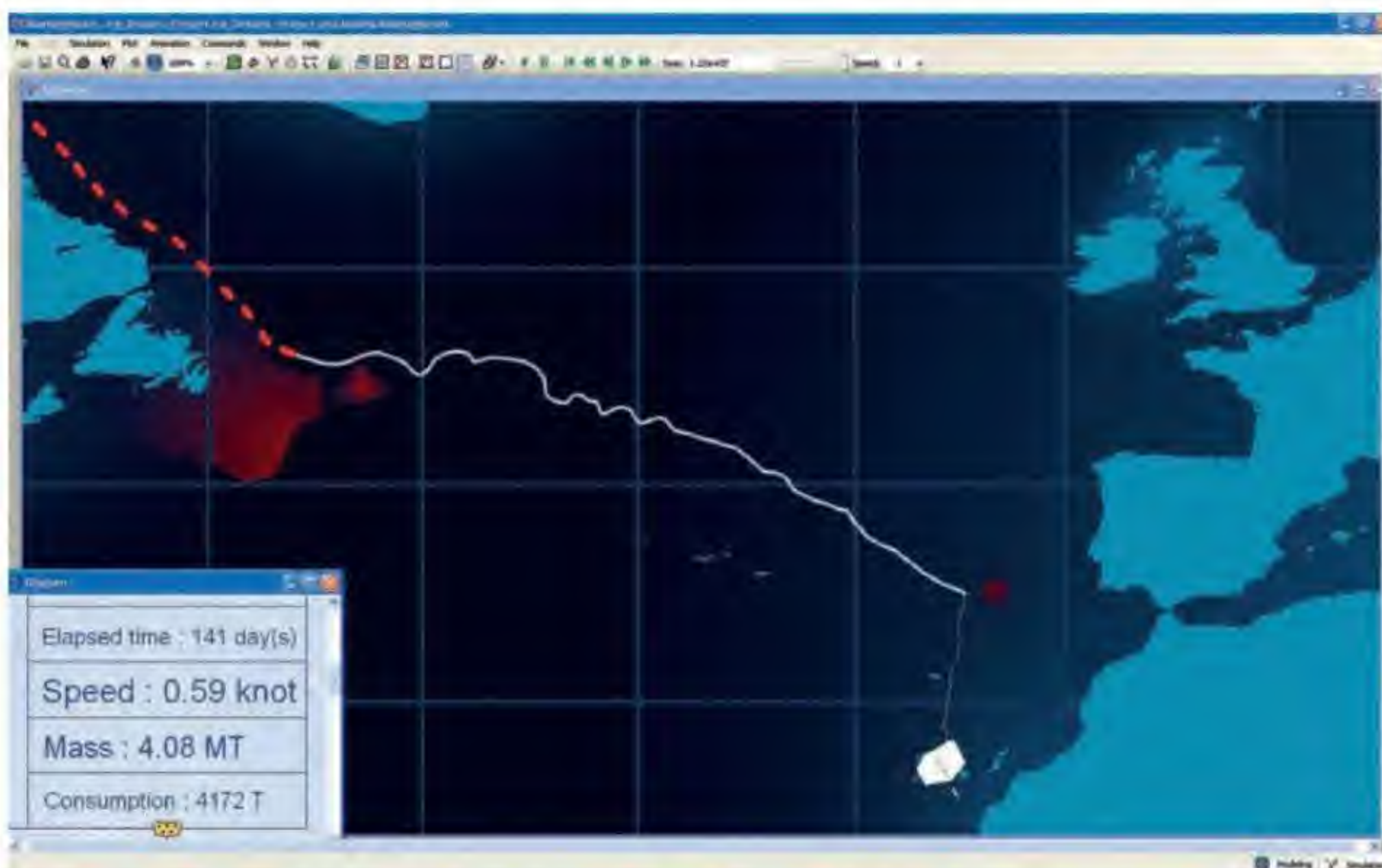
the coasts of Morocco, Namibia, western and south Australia, Chile, Peru and even California.

In 2009, Mougin knocked at the door of Dassault Systèmes, a well-connected firm that bills itself as a 3D experience company that provides businesses and people with "virtual universes to imagine sustainable innovations". Having just watched a 3D interactive documentary titled *Khufu Revealed*, he decided that the company's 3D simulations and other techno-wizardries would allow his theories on iceberg-towing to be tested virtually.

Dassault Systèmes worked with Mougin and his team to simulate the iceberg's trajectory and its evolution, taking into account data such as variations in ocean temperatures, wind force and direction, sea currents and boat drag force. They inserted this data into a 3D model of the iceberg to simulate what would happen all along the voyage.

Some important questions needed to be answered. Could an iceberg be towed from point A to point B? If yes, how many boats would be needed, and how powerful should they be? How much fuel will be consumed? How long would it take to tow the iceberg from Newfoundland to the Canary Islands, for example? How could scientists prevent the iceberg from melting and disappearing into the ocean?

Mougin intends to 'catch' a real iceberg, wrap it with a protective skirt and tow it to a country desperate for potable water.



Working closely with Georges Mougin and his team, experts at Dassault Systèmes simulated an iceberg tow from Newfoundland to the Canary Islands. Using Simulia and other software, they traced this slightly erratic route while taking into account such variables as wind, ocean currents, wave height and the albedo (reflecting power) of the iceberg.

SIMULATING THE WORLD'S BIGGEST TOW

This picture, and below: Having scanned a real iceberg with radar, the researchers produced masses of useful data, including the duration of the voyage, the number of boats required to do the job, their fuel consumption – and most critical of all, how best to prevent the iceberg from melting before reaching its destination.



The critical challenge presented to Dassault Systèmes' engineers was to demonstrate, using virtual technology, the technical feasibility of displacing the iceberg in a controlled manner while reducing its melting. The project, managed by Cédric Simard, interactive strategy and marketing project director, involved several steps:

- Model the iceberg with CATIA software, based on a cloud of points obtained by scanning a real iceberg with radar.
- Calculate and simulate the way the iceberg would melt using CATIA and Simulia software.
- Simulate the way the iceberg would melt if surrounded by the protective isothermal "skirt" imagined by Mougin to slow the melting process.

- Calculate how much fuel the boats would consume, depending on the winds and currents encountered along the way.

Various scenarios were simulated, such as number of boats needed, different departure dates and climate conditions, and the behaviour of the boats and iceberg in the event of a storm or turbulence. In addition to enabling the team to visualise these scenarios, the simulation allowed scientists to test the deployment of the isothermal skirt around the iceberg.

Says Simard: "We were able to test many scenarios in a short space of time – something that would have taken years and considerable resources if we were to do this in the real world. It is easier to manipulate a 7 million-ton iceberg with 3D virtual technology and to perform analyses that are very close to reality."

Virtual simulation can also be used to

train people to install the protective skirt around the iceberg, or to pilot the boat while towing it. Training scenarios can be repeated as often as necessary and varied by modifying test parameters at will and at no extra cost. "It's safer and less expensive than training people on a real tow boat out in the ocean," Simard says.

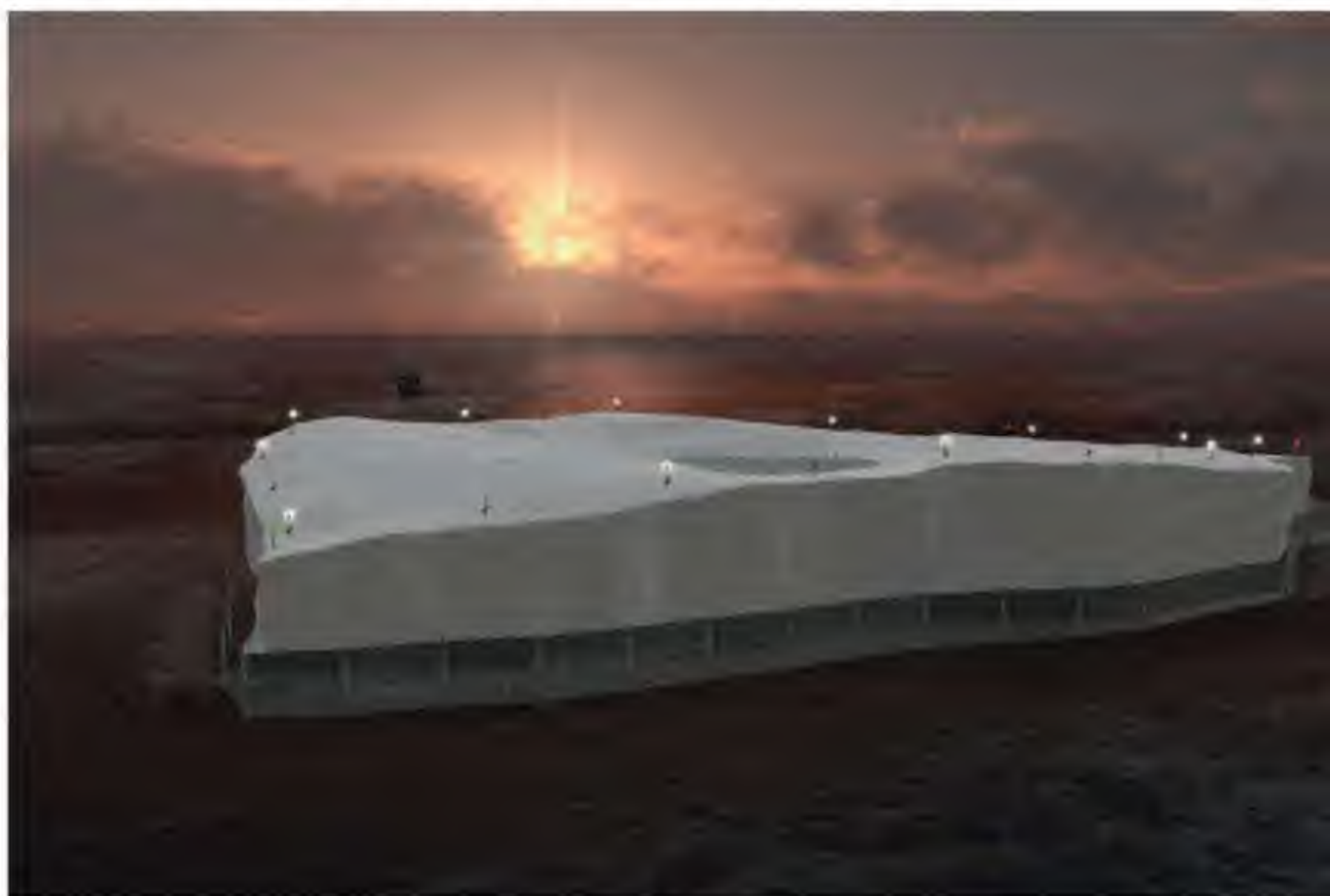
"Virtual simulation also has environmental advantages, since even the wildest ideas can be tested without any adverse effects on the environment."

For Mougin, seeing his project come to life has been a major step forward, and

the results are sufficiently encouraging for him to proceed with a real-life prototype operation some time in the near future. His plan is to "catch" a real iceberg, wrap it with a protective skirt and tow it a few kilometres.

"What I imagined 35 years ago is finally on its way to becoming reality. Although there are still some technical aspects to be explored, virtual simulation has proven that this project is technically feasible and not such a wild dream after all."

Source: Dassault Systèmes



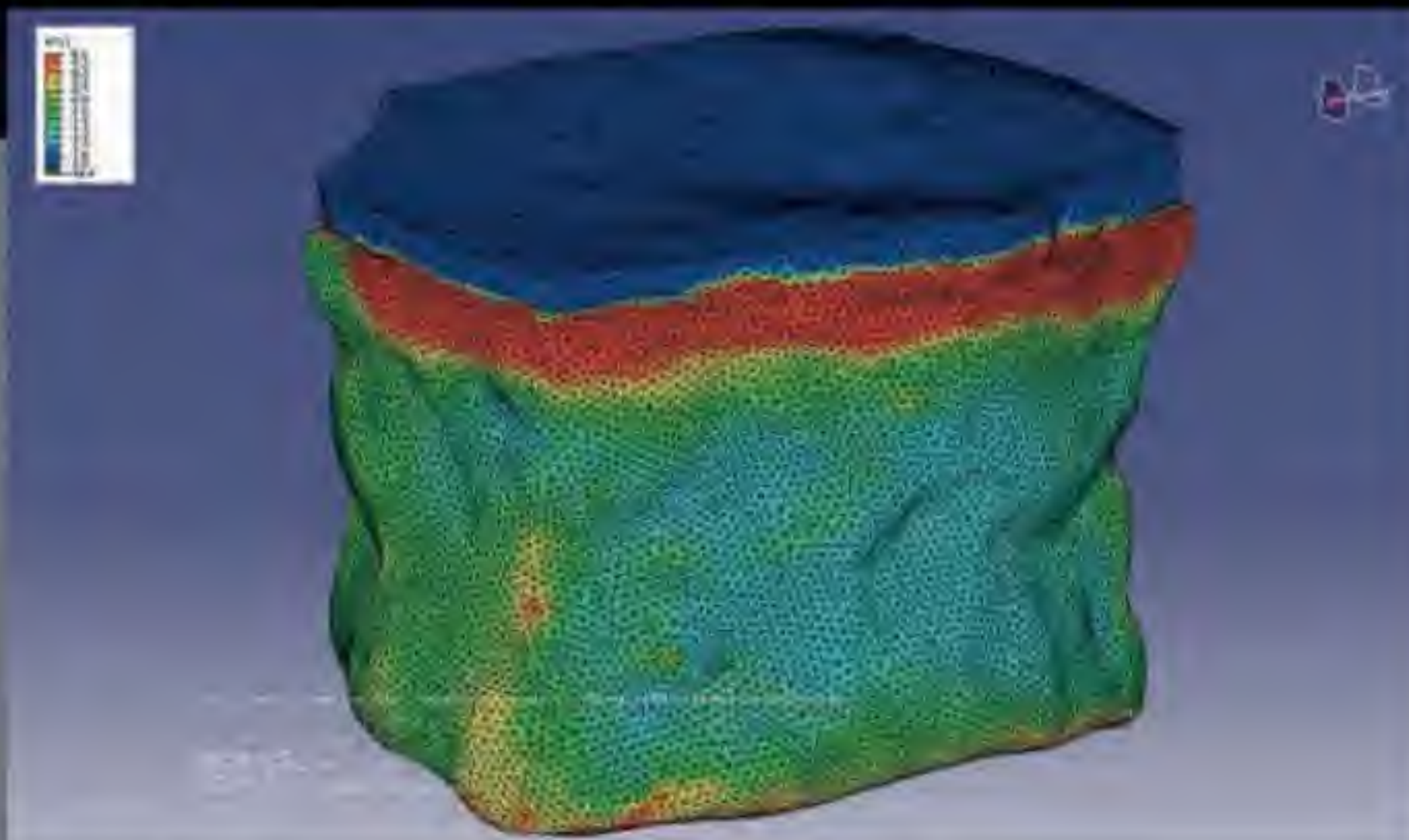
THE FIRST STEP: Simulating the interactions between the iceberg, protected by the isothermal skirt, and the natural environment. Through a series of experiments, and in order to reproduce the actual conditions experienced by the iceberg, the research team varied parameters such as the speed and temperature of the sea currents and winds – even the height and wavelength of the swell – in hydraulic simulations that resulted in precise mapping of the heat exchanges that occurred between the iceberg and its environment. This mapping was used in the second stage of simulating the iceberg melting process: thermal simulation.

Using Simulia software, the researchers were able to observe the behaviour of the iceberg as it melted. Interestingly, the upper section melted more slowly (due to the albedo, or reflecting power, of the white ice) than the walls of the iceberg at the waterline, which were clearly affected by the swell. This result reinforced the importance of the floating skirt in Mougin's concept.

However, it was the vertical side zones with deep crevices that experienced the most rapid melting. This was hardly surprising: it follows that the larger the surface area in contact with the water, the more rapid the rate of melting. If common sense predicted that an isothermal skirt and a cushion of water around an iceberg would slow its melting considerably, the simulations gave it scientific proof.

After months of intense collaboration, this time using Dymola software, the team produced an integrated drift model that consolidated all the relevant criteria involved in the operation of transporting the iceberg:

- Meteorological and oceanographic data that the convoy would encounter at any time or place, and their impact on the convoy's movement.
- The principles of melting resulting from hydraulic and thermal simulations, which would allow the evolution of melting to be observed throughout its transportation.
- The physical phenomena, especially those corresponding to the drift of the iceberg and the convoy under the effect of various natural forces (winds, currents, swell, etc), the traction force exerted by the tugboat and the resulting consumption of fuel oil, the consideration of the effects on the tugboat and the iceberg of the drag due to both the water and the air, the rotation of the Earth (the Coriolis effect), and so on.



In the Dymola software, the Dassault Systèmes experts entered the GPS co-ordinates of the iceberg's initial location near Newfoundland, and of its destination in the Canary Islands, selected a departure date for the convoy (June 3) and the number of tugs to be used to tow the iceberg, as well as the power of the tugs. Finally, they selected the general piloting strategy, just as the captain would in real life.

Two minutes later, the simulation ended and delivered the results: total duration of the project, remaining mass of ice on arrival, total consumption of fuel oil. On a world map, the computer plotted a convoluted curve describing the complete course followed by the convoy. The researchers were able to replay it slowly to see what happened at each instant, and to analyse the causes and effects in relation to the various parameters. Among other things, they were able to deduce how much ice remained on arrival at the destination, and what quantity of fuel oil the tugboat burned in accordance with the route followed. In the simulation, each voyage took about 150 days because the convoy travelled at an average speed of 1.5 km/h.

Not surprisingly, a project on this scale carries risk. An iceberg is made up of fragile material – ice that can break up violently without warning, due to the combined effect of natural imperfections when it was created and environmental damage such as the effects of temperature, water erosion, wave action and storms.

Digital simulation, together with earlier observations by scientists of an iceberg break-up, enabled the researchers to evaluate the potential environmental risks connected with the break-up of the ice colossus – and the results were a little scary. One block sank deeply before resurfacing, another rose up several tens of metres before regaining its equilibrium.

Because of the huge volumes of ice involved, the result was "total chaos" in the surrounding environment, with waves measuring 50 to 60 m high and currents of 60 to 80 metres per second. In such a scenario, said the researchers in a masterpiece of understatement, it was "best to have taken the appropriate safety measures beforehand". **PM**

Top: An analysis of the iceberg's thermal patterns helped researchers to calculate its melting rate as it was towed.

Left: Mougin's plan calls for the iceberg to be fitted with an isothermal "skirt" to slow the melting process.





STAR CHART

Choose a printed map or an app with a red-light mode, such as GoSkyWatch.

BINOCULARS AND MONOPOD

Use 10x50 binoculars or, to hunt for less luminous objects, 15x70. To support and swivel them during sustained stargazing, a monopod is helpful.

GUIDE WHAT TO TAKE



INSECT SPRAY

Nothing spoils a great night of observation faster than mosquitoes.



LAYERS

Even in summer, night-time temps and dewy grass chill.



TORCH

Red light only: it preserves night vision. (White light from a cell-phone kills it.)



CAMP CHAIR

Avoid neck strain by leaning back in an adjustable camp chair.

STARGAZING MADE SIMPLE

BY ADAM HADHAZY

Binoculars don't just bring birds into focus – they're a cheap, portable tool for zooming in on the night sky, too. The handheld lenses let you examine a wide field of view, right side up and with both eyes, unlike most backyard telescopes. Robin Scagell, co-author of *Stargazing With Binoculars*, advises setting up shop at least 2 kilometres from well-lit areas. "Avoid looking at bright lights before you go out," he says. "And give yourself 20 minutes to let your eyes adapt to the darkness."

Start by checking out craters in the nearly full Moon, which in South Africa will be in the northeastern portion of the early night sky in early September. Then look for Mars and Saturn hugging the horizon to the southwest. Pick up the trail of the Milky Way arcing overhead, and follow it to features such as the Butterfly Cluster and Eagle Nebula. To spot fainter objects, wait until the Moon wanes. Scagell also suggests relying on more sensitive peripheral vision: gaze to the side rather than directly at where an object is located.

PM

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Pro motor techies wanting to fathom the complex inner workings of modern vehicles can't go wrong with Snap-on's Solus Ultra full-function diagnostic scan tool. Not only is it capable of delving into the electronic minds of European, Asian and US vehicles built from 1980 onwards, but it does so with minimal fuss. Featuring an 18 cm daylight-readable colour touchscreen display and user-programmable shortcut key, it allows you to control vehicle functions while viewing live data results on the screen. A single keyless adaptor covers all OBD-II applications. It's ready to work in just 10 seconds, and charges directly from the vehicle, so you don't have to down tools and wait while it recovers. Price: about R34 200. Contact Snap-on Africa on 0861 762 766 or visit www.snapon.co.za



GO WITH THE FLOW

If your tech-savvy brood expect to simultaneously watch movies, play games and browse the Web via their iPads or other devices, chances are your home network is taking strain. In this case, Western Digital's My Net N900 dual-band router could be the answer. It detects entertainment traffic on the network and fast-forwards it to gaming consoles, media players, smart TVs, smartphones, computers and other Wi-Fi connected devices.

Thanks to its user-friendly and intuitive interface, even novices should find the set-up a breeze. As for fiddling with network settings (think parental controls, Internet security, guest network access, printer settings and the like), well, that's pretty simple, too. It delivers up to 900 Mbps (450 + 450 Mbps on the 2,4 and 5 GHz bands combined) for seamless streamed video, and features 7 LAN and 1 WLAN Gigabit Ethernet ports and 2 USB ports for additional storage, printer and media share use, and range amplifier antennas. Price: about R3 000. Visit www.wdc.com



WATCH FOR THE WEATHER →

The last thing you need when mucking about outdoors is to be caught out by the weather. Casio's latest high-performance outdoor watch, the solar-charged PRO TREK PRG-250, effectively straps a weather station to your wrist. Featuring a triple sensor that incorporates a compass, barometer/thermometer and altimeter, it's a great tool for those involved in adventure sports such as mountain climbing, river rafting, kayaking or diving.

The large dual-layer electroluminescent backlit LCD display is easy to read. In addition to displaying atmospheric pressure numerically and in a trend graph, it uses arrow icons that allow you to ascertain abrupt weather changes at a glance. Other features include a tough resin/aluminium case with mineral glass, directional bezel, bearing memory, 200 m water resistance, countdown timer, Moon data and tide graph. Price: about R5 000. Contact distributor James Ralph on 011-314 8888 or visit www.jamesralph.co.za



CHAT WHILE YOU DRIVE ↑

According to the clipboard brigade, a whopping 20 per cent of car accidents involve cellphone use of some kind. So to play it safe (and, if you live in the Western Cape, avoid a budget-busting fine plus the confiscation of your phone for 24 hours), we suggest you take Parrot's Minikit Smart hands-free kit for a spin. Designed to accommodate most smartphones, it comes with a suction foot that attaches firmly to the windshield or dashboard, enabling you to access your phone's navigation and call features easily.

Its integrated lithium-ion battery (recharged via a 12 V cigarette lighter socket) reportedly lasts for more than a week, and it'll charge your phone via its USB port. Verbal instructions from your phone's navigation system are transmitted through the integrated 2 W speaker, and when you receive a call, the navigation instructions are interrupted automatically. Price: about R1 000. Contact SMAC on 0861 888 222 or visit www.smac.co.za



GET INTO YOUR GROOVE ↑

Budding DJs wanting to create their own beat should get their hands on Magix Music Maker MX. This software package includes 1 500 sounds and a mixer with effects, making it possible for anyone to compose their own music – from rock to alternative, hip hop, techno and electro. Heck, you can even incorporate parts from your favourite songs and turn them into something completely different. Best of all, no previous musical knowledge is required.

It supports VST effects and instruments. A loop designer offers a range of possibilities, there's a lead synthesiser to help you create jaw-dropping good vibes, and its drum engine allows you to dance to your own beat. You can also share your creations on Facebook with just a few clicks. Price: about R900. Contact distributors Phoenix Software on 011-803 5437 or visit www.phoenixsoftware.co.za



LISTEN UP

Music on the run can help ease the tedium of jogging. However, getting hit by a bus because your Club Favourites playlist distracted you kind of negates the health benefits of exercise. That said, the Aftershokz Bone Conduction Headphones (available in Sport and Mobile models) lets you to listen to music while still paying attention to the world around you.

Unlike conventional headphones and earbuds, which use the eardrums to transmit sound, these headsets sit comfortably in front of the ear to deliver stereophonic sound via the listener's cheekbones to the inner ear. Aside from the obvious benefit of not destroying your eardrums whenever you crank up the volume, they're also said to be much more comfortable to wear for long periods than conventional options. The benefit of the Mobile model over the Sport is that it features an in-line microphone, allowing you to take calls while you're working up a sweat. Prices: about R800 for the Sport and about R900 for the Mobile. Contact distributors Premium Brand on 021-461-2325 or visit www.aftershokz.com



BRING THE WORLD TO YOUR EARS

Would you like to tune in to Italian opera from Milan, rock music from New York, or any other speciality niche radio station from anywhere in the world, in real time? Then Tivoli Audio's new NetWorks Stereo Global Audio System is clearly the way to go. This desirable piece of kit provides access to thousands of crystal-clear radio stations without the need for a roof-top antenna, a degree in shortwave communication or, in fact, a computer. Instead, all you need is a wireless home network or an Ethernet connection.

It gets better. The system automatically upgrades its own software, so you always have the most up-to-date version. It can stream music files from your PC, and features a USB input for connecting compatible MP3 players or memory sticks. There's a digital clock with dual independent alarms, a snooze function and a sleep timer. It also comes with an auxiliary input, headphone output and compact remote control. Price: about R7 000. Contact i-Fi on 021-421 2209 or visit www.i-fi.co.za



BLOW IT AWAY

Garden blowers eliminate the hassle of sweeping or raking your debris into neat, manageable piles. What a pity they're such damn noisy machines. Stihl's new BGA 85 cordless blower is different: powered by a rechargeable 36 V lithium-ion battery, it gets the job done with minimal noise and no smelly emissions.

But that doesn't mean it's a wimp. The two-stage axial blower blasts air at up to 46 m/s (measured at the nozzle) and the airflow is infinitely variable, courtesy of a conveniently placed lever. The motor runs at full speed until the battery is depleted, with no irritating gradual drop in power. Bonus: lefties can use it comfortably. Price: about R9 000 (including battery and charger). Contact Stihl on 0800 336 996 or visit www.stihl.co.za



SEE WHO'S TALKING →

Catching the dreaded "redeye" to attend an early business meeting in another city may become unnecessary if you have Yealink's VP530 video phone at your disposal. This all-in-one business communication tool offers three-way video conferencing without the need for specialist systems, making it ideal for corporate execs as well as those who work out of their homes.

Features include a large full-colour touch-screen, a business-oriented user interface, and full integration with industry standard directory and phone-book systems. It comes with a high-quality hands-free speakerphone and can be connected to a video projector or external display. An Ethernet port makes it easy to connect to your corporate network. Price: about R3 500. Contact distributor Nology on 012-657 1317 or visit www.nology.co.za



CHARGE ON THE GO ↓

Charging your must-have toys while away from the grid has just got a whole lot easier, thanks to Powertraveller's Solarmonkey Adventurer. This nifty gadget features two polysilicon solar panels (with a maximum output of 3 watts) as well as a 2 500 mAh internal lithium polymer battery, enabling you to power up devices such as iPhones, iPads, mobile phones, portable gaming consoles, handheld GPS systems, e-readers and the like.

Its auto-load self-sensing switching technology allows it to optimise the charging parameters for each gadget automatically. A solar energy detection feature activates the state-of-the-art MPPT (maximum power point tracker) technology, making charging devices in low light conditions more effective. It also comes with a host of protection features, including short-circuit, overload and low voltage. Plus, thermal insulation battery protection gives it an operating temperature range from minus 10 to 90 degrees. There are three charging options: solar panel, USB and international mains charger (not included). Price: about R1 200. Visit www.mobilegadgets.co.za



ON LAND OR AT SEA ↑

Because a navigation device should direct you to wherever you want to go, Garmin's GPSMAP 620 makes perfect sense. This multifaceted GPS combines both marine and automotive functionality in one handy unit.

It comes with a preloaded worldwide satellite basemap for view-from-space depictions of shorelines and other surface features, as well as a worldwide automotive routable basemap. However, when loaded with BlueChart g2 Vision mapping for South Africa (costing about R2 400), it transforms into a fully functional marine chartplotter, giving you 3D Mariners Eye view above the waterline, Fisheye 3D views below the waterline and all the navigational pointers you could wish for. And, when inserted into its optional automotive dock (and loaded with Garmap Africa Series Streetmaps, costing about R1 000), it becomes a fully functional automotive GPS.

Other features include a high-sensitivity internal receiver and waterproof case, 13,2 cm touchscreen display and a rechargeable lithium-ion battery with a run time of up to 9 hours. Price: about R7 100. Contact Garmin Southern Africa on 0861 427 646 or visit www.garmin.co.za





CAPTURE WHAT YOU SEE ↑

Even Superman would be hard-pressed to beat Sony's DEV-5 Digital Recording Binoculars, which endow us mere mortals with the ability to record distant action in 3D or 2D Full HD video, shoot 7,1 MP still photos, and then play everything back from the comfort of our couches.

Featuring a 20x zoom (10x optical and 10x digital), these binocs use two Full HD sensors to capture true 1920x1080 3D video. Optical SteadyShot image stabilisation compensates for camera shake to deliver smooth footage, even when you're walking and zooming in from wide to tele-photo and back. The Exmor R CMOS sensors are said to perform well in low-light conditions for those dusk and twilight birding excursions and the professional-quality G lens is designed to deliver brilliant colour and detailed images on any setting. Its autofocus function works continuously, ensuring your view remains sharp throughout the zoom range. A built-in GPS receiver enables you to geo-tag your footage. Price: about R20 000. Contact Sony SA on 011-690 3555 or visit www.sony.co.za

PUMP UP THE VOLUME ↓

As great as laptop computers are, they all have one feature you can bank on: underwhelming sound. Verbatim's Portable USB Audio Bar goes a long way towards resolving this inherent shortcoming. Two pre-amplified magnetically shielded metal drivers with a total output power of 2 watts RMS provide volume levels from soft enough for personal use to loud enough for boardroom presentations.

It features a retractable clip to secure it to any notebook while in use without damaging the screen, as well as a 58 cm cable so it can be positioned on a desk or table for optimal sound. And, as it takes up less space than most laptop chargers, when it's time to pack up and move, all you need do is unhook it and pop it into your laptop bag. Price: about R190. Contact distributor Drive Control Corporation on 011-201 8927 or visit www.drivecon.net



GIVE IT A BASH ↑

Active outdoor types looking for a reasonably priced smartphone that can take some punishment should check out Motorola's new Defy Mini. Dust-proof, water-resistant and with a scratch-resistant Corning Gorilla glass display, this handset is tough enough to handle whatever challenges you throw its way. Its long battery life (up to 10 hours of talk time and 21 days on standby) means you won't be running around looking for a charging point. And, as it runs on Android's Gingerbread platform, you can access the thousands of games, apps, music tracks, books and movies available in the Android marketplace. You can also snap photos of your adventures with its 3-megapixel camera, and use the front-facing VGA camera to video chat with your best friends.

Other features include an 8,1 cm HVGA capacitive touchscreen, GPS navigation, FM radio, expandable storage, and Bluetooth and Wi-Fi connectivity. Price: about R2 000. Contact Vodacom on 011-653 6530 or visit www.vodacom.co.za

PM



I just received a new BlackBerry® and was wondering what prepaid options are out there.

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I literally only use my phone for social networking, and was wondering if there is a product that is geared for this. I really don't need much more than that.

You can enjoy access to Facebook and MXit via m.facebook.com and m.mxit.com with the Social Networking Internet Voucher (R29) from MTN. Just dial *141*6# to start the fun. (Please note: an out-of-bundle rate of R0.65 per MB applies to MTN PayAsYouGo MTN TopUp customers.)

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HOW TO MINE AN ASTEROID

BY MICHAEL BELFIORE

In April, a group of aerospace veterans and investors, some of whom are pictured below, announced an audacious venture: a company, Planetary Resources, dedicated to mining asteroids. "Breakthroughs require taking extraordinary risks," says co-chairman Peter Diamandis. The company, backed by technology trailblazers such as Google CEO Larry Page, movie director and inventor James Cameron, and Microsoft software guru Charles Simonyi, does not expect a fast return on investment. "Within a small number of years, we'll be flying to asteroids," says co-chairman Eric Anderson. "But we have a 100-year view for this industry."

THE
2049ERS



Eric Anderson
Space Adventures



Peter Diamandis
X Prize Foundation



Larry Page
Google co-founder



Charles Simonyi
Two-time
space tourist

SPACE MINERS WANT TWO THINGS:



WATER

A 7-metre-diameter carbonaceous chondrite (C-type) asteroid can hold 90 000 litres of water, which could be used to make rocket fuel or replenish spacefarers.



METALS

A 24-metre-wide metal (M-type) asteroid could hold 30 000 tons of extractable metals, including R400 million worth of platinum alone. But can a mining spacecraft cut off treasure from these metal objects?

EROID



STEP 1

GET PROSPECTING

To mine an asteroid, a company such as Planetary Resources first has to find one that promises a good return on investment. But asteroids don't glitter like stars. They are small, dark and easily obscured by the distorting effect of Earth's atmosphere. The best way to hunt for them is with a telescope floating in space. At the Washington headquarters of Planetary Resources, chief engineer and company president Chris Lewicki is assembling the components of the first privately owned space telescope, the Arkyd 100 series.

The 20-kilogram spacecraft will be smaller and simpler than any government-funded space telescope. The R12 billion



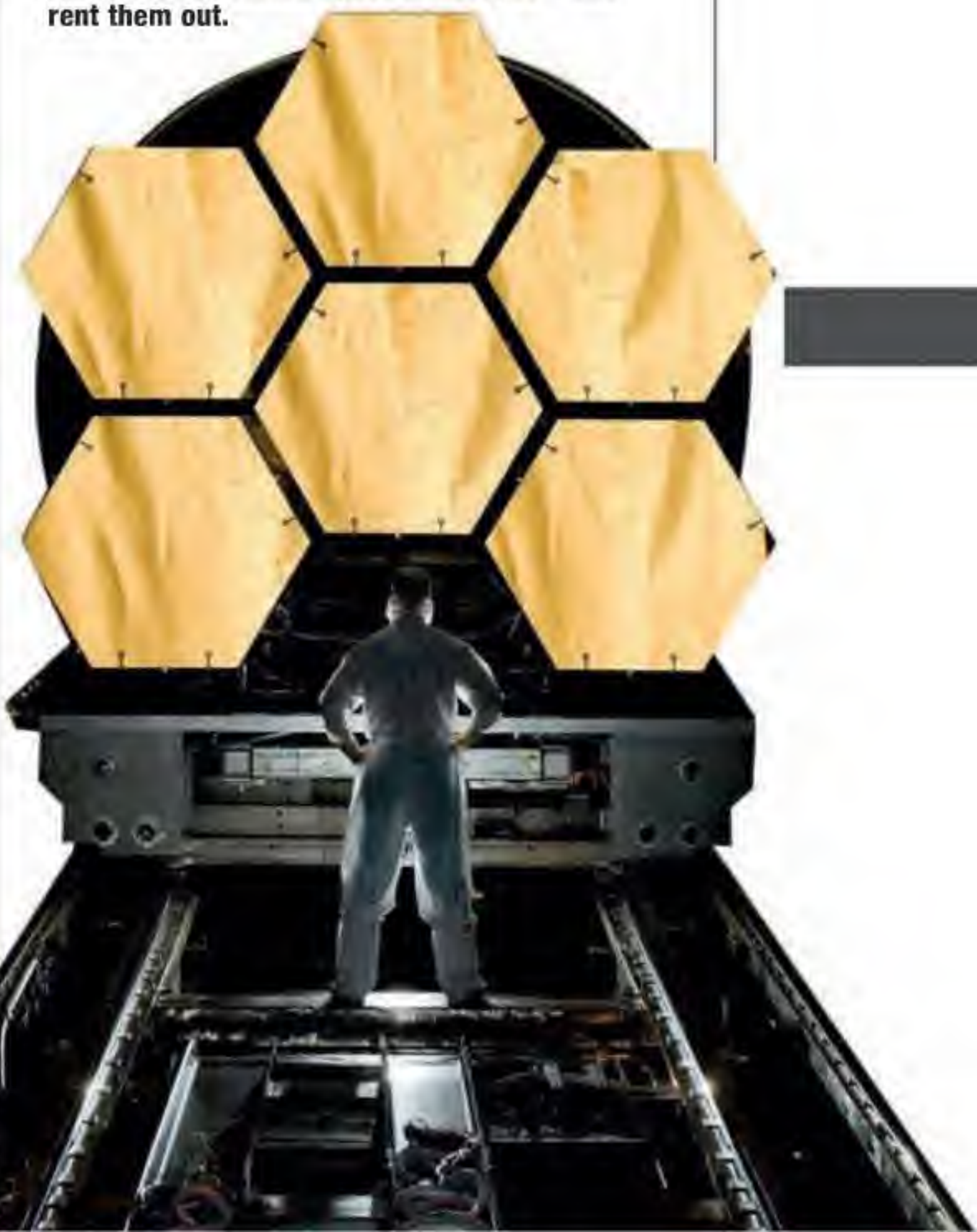
Visit www.popularmechanics.co.za to hear what Planetary Resources – the company behind the initiative – has to say about mining asteroids.

Hubble Space Telescope has a 239-centimetre-diameter primary mirror; Arkyd's mirrors will be 29 cm wide. Hubble has a wide field of view, as well as other instruments to scan objects in distant space. Arkyd needs only to look in our own solar system for targets. Being small saves money: rockets carrying larger sats could also haul these telescopes as secondary payloads, decreasing launch costs.

Planetary Resources plans to build a fleet of space telescopes to help drive the per-unit cost down to less than \$10 million (about R80 million). Having multiple telescopes is insurance in case one fails. "We need to make something in an assembly line," says Lewicki, a former Jet Propulsion Laboratory Mars mission manager. "We can't just build one precious jewel that we treat with kid gloves."

The Planetary Resources team will also rent out the Arkyd 100s, the company's first stab at making money. Its space telescopes can be used by cosmic researchers or by Earth scientists who want to examine the planet from space at a resolution of about 2 metres per pixel. Planetary Resources hopes to launch the first satellite by the end of 2013; company officials say rental prices have not yet been determined.

A Nasa engineer stands in front of six segments of the James Webb Space Telescope's primary mirror. Space miners may field the first privately owned space telescopes – and rent them out.



STEP 2

ASSAY AND STAKE

Once company telescopes spot a mining prospect, there's only one way to determine what resources the asteroid contains: get close.

The Planetary Resources team envisages a swarm of prospecting bots heading out to conduct close flybys of near-Earth asteroids (NEAs). "We're talking about building interplanetary probes at a fraction of the cost (of current models), which requires doing things very differently," Diamandis says.

Nasa has used this form of propulsion twice for deep-space exploration. It uses electricity to positively charge xenon atoms, which are pulled out of the craft by magnets. The repulsive force provides thrust that propels a vessel, building speed over the course of years. It takes a while, but when it gets going the craft can exceed 300 000 km/h.

The asteroids of interest likely will be less than one and a half kilometres in diameter, too small to have appreciable gravity. Spacecraft don't land on such small asteroids; they dock to them. A spacecraft will slowly approach, getting close enough to barely touch the asteroid's surface before deploying an anchor. Grappling hooks might just grab a chunk of surface material and float away. A better option is to deploy drills in each landing pad that secure the craft to the surface.

The robot would then analyse the water and metal content of the asteroid and beam the results to Earth. The tool of choice for this assay would be a laser-induced breakdown spectroscopy system, or LIBS. Lasers vaporise surface material so sensors can analyse the light emitted by the resulting plasma to identify elements. The first LIBS to be deployed to another world, ChemCam, is currently en route to Mars aboard Nasa's Curiosity rover.



STEP 3



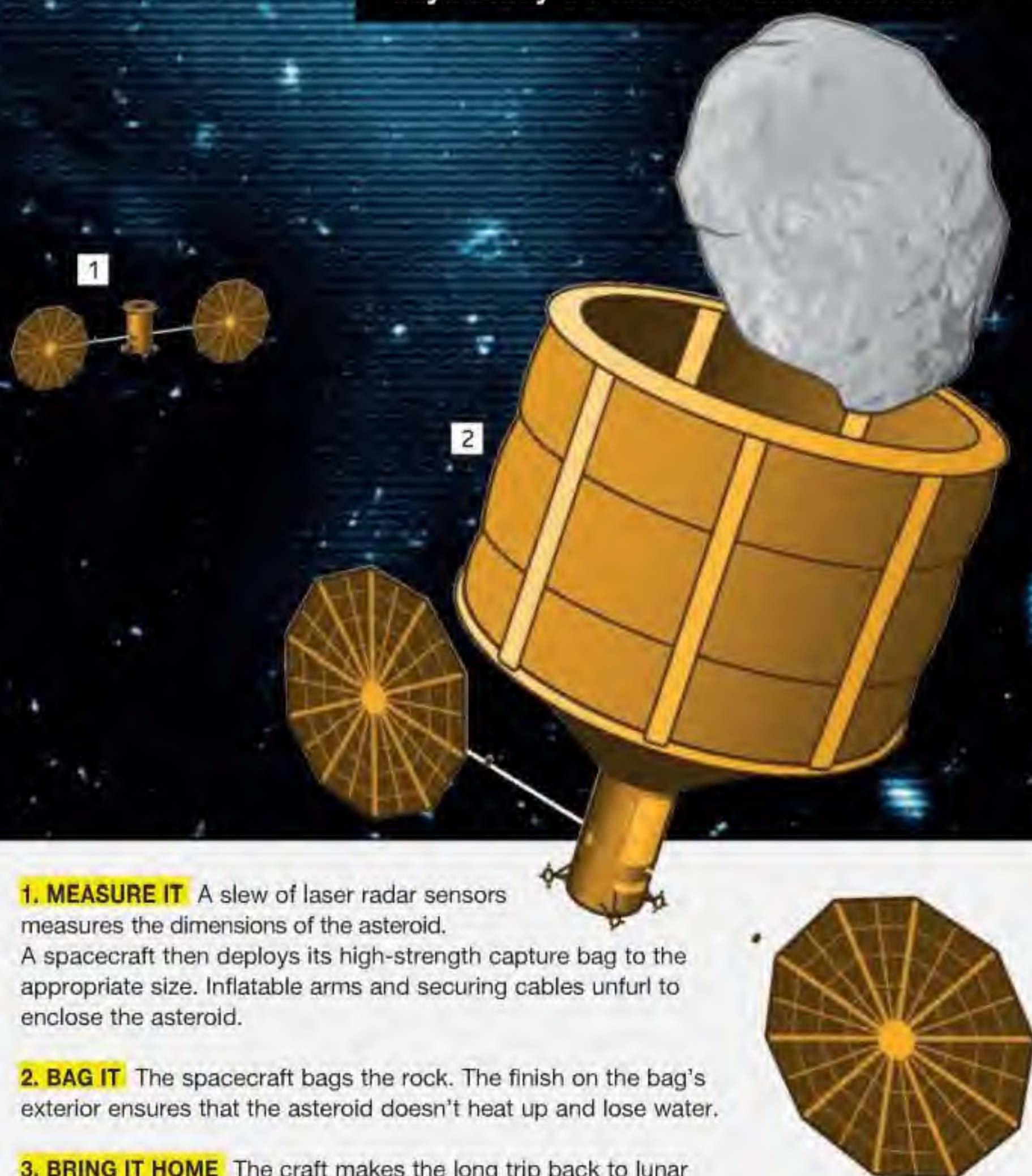
A prototype robot, created by Nasa's Jet Propulsion Laboratory, has 750 steel hooks for feet. These adhere to rough surfaces, preventing bots working in low gravity from drifting away.

START DIGGING

A CLAIM

ONE ASTEROID TO GO, PLEASE

Asteroids could be brought closer to home for study and mining. In an April publication, the Keck Institute for Space Studies, based at the California Institute of Technology, Caltech, looked at how to bring one to lunar orbit. Such a rock could provide an attractive destination for astronauts. "The mission will be a stepping stone into the solar system," says study co-leader Louis Friedman.



1. MEASURE IT A slew of laser radar sensors measures the dimensions of the asteroid. A spacecraft then deploys its high-strength capture bag to the appropriate size. Inflatable arms and securing cables unfurl to enclose the asteroid.

2. BAG IT The spacecraft bags the rock. The finish on the bag's exterior ensures that the asteroid doesn't heat up and lose water.

3. BRING IT HOME The craft makes the long trip back to lunar orbit. The return trip could take six years; mining commences on arrival.

The prospecting craft might also tag the asteroid by planting a radio beacon on its surface. According to company officials, the beacon would do more than help future missions get a fix on an asteroid's location. "Placing a beacon is part of building a case for ownership," Diamandis says.

A private company's claim to an asteroid is uncharted legal territory. In the next decade lawyers may have to factor in the presence of private-sector entrepreneurs in the Outer Space Treaty, first signed in 1967 and ratified by more than 100 nations. If it turns out that possession really is nine-tenths of the law, then a simple radio transmitter could help make the miner's case.



Space miners will prize water more than gold. Its value manifests when it is split into its elements: hydrogen can recharge power cells and be recombined with oxygen to produce energy-rich fuel. Harvesting water in space is cheaper than shipping it from Earth. Every litre, at a weight of a kilogram, can cost tens of thousands of rand to launch. Planetary Resources could profit by selling space-harvested water to governmental or private spacecraft at a premium, but for less than it would cost to deliver from Earth.

Carbonaceous chondrite asteroids are the best prospects for water. The surface of these so-called C-type asteroids is crumbly, says John Lewis, professor emeritus at the University of Arizona and author of *Mining the Sky*, the seminal book on the space industry. "You can hold a cube between your thumb

ASTEROID MINING INFRASTRUCTURE

ORBITAL TRANSPORTATION HUB

A larger, manned space station is an ideal place to co-ordinate flights of cargo, mining gear, and explorers.

SPACE FUEL DEPOT

Spacefarers will need places to restock water and hydrogen for fuel (think space filling stations). Scientists today are working on ways to transfer fluids in zero-g.

DEEP-SPACE COMMUNICATION RELAY

Optical laser communications systems transmit as much data as radios and can use half the power. Planetary Resources is developing a system under contract with Nasa.

and your forefinger and crush it," he says. There's no need to burrow; you can just scrape the surface of a C-type asteroid to mine its water.

A swarm of mining bots, clinging with barbed feet to the surface of an asteroid, would slurp up water-laden soil through proboscis-like drills, while others would vacuum the debris left in their wakes. The robot would then pull out the soil, or regolith, and deposit it in a sealed container. The robot would walk, float or crawl to a processor lashed to the surface or floating above it. The processor would heat the regolith to release water vapour, which

would be collected into a storage tank.

Space miners face a more difficult challenge when harvesting metal. M-type asteroids, essentially big flying chunks of solid metal, might not feasibly be mined, says Harry McSween, geoscientist at the University of Tennessee and chair of the surface composition group for Nasa's Dawn asteroid probe. Anchoring to such a body would be hard enough – drill-style landing pads wouldn't work – let alone sawing off a chunk of the asteroid for processing. "When you think about how much energy would be required, it seems pretty unrealistic," McSween says.

But Lewis figures that some asteroids might be made up of as much as 30 per cent metal, in the form of an iron-nickel-cobalt and platinum-group alloy. "The temptation is to simply use a magnet to pluck the metal grains out of that regolith," he says.

Some metal-rich asteroids might be worth taking closer to Earth, as close as the Moon, in their entirety. "The concentration of metal is so high that you have to wonder whether you could just bring the whole thing back," Lewis says. (It's not so far-fetched; see "One asteroid to go, please".)

OUR RICH SOLAR SYSTEM

Between 2009 and 2011, a Nasa space telescope called the Wide-field Infrared Survey Explorer (WISE) catalogued asteroids in our solar system. It found:

- More than 100 000 previously unknown asteroids in the belt between Mars and Jupiter.
- 19 500 mid-sized near-Earth asteroids.
- 4 700 large, potentially hazardous asteroids that cross within a cosmically close 8 million kilometres of Earth's path. (Nasa estimates that it has catalogued only 30 per cent of them.)



SPACE MINING TECH

MAGNETIC RAKE



There is no need to dig mines to gather precious metals from space rocks. By placing a magnet on each prong of the rake, loose regolith (asteroid soil) can be combed easily for precious metals in low gravity.

LOW-GRAVITY SIFTERS



Old-school gold miners rejoice. In 2009 scientists used a vibration table to shake soil through a sieve to separate the particles that would burn most efficiently in an oven; heated asteroidal material releases oxygen. The system worked in zero-g, simulated by parabolic flights of an aircraft.

ASTEROID ANCHORS



With almost no gravity, asteroids won't be easy to land on, let alone allow for operating drills and other mining equipment. Nasa's Jet Propulsion Laboratory is developing steel "toenails"; Honeybee Robotics is creating screw-in augers to keep space machinery from floating away.

DELIVER THE GOODS

Space sells, but who's buying?

It remains unclear who will purchase the goods that space miners have gone to such pains to gather.

The most lucrative opportunity might be platinum-group metals, one category of the few space commodities that would be shipped

back to Earth. "These materials enable so many different high-tech processes that we use," Lewicki says. Today, platinum-group metals are essential to catalytic converters in petroleum engines, as catalysts in the production of silicone, and in the manufacturing of glass. They are incorporated into hard drives; in spark plugs, where their low corrosion rates allow

150 000-kilometre life-spans; and in medical devices, where they are prized for their biocompatibility.

A 500-ton asteroid with 0,0015 per cent platinum metals – a common percentage – would have three times the richest concentration found on Earth. "To have more of this material will open up economies that we can't even predict," Lewicki says.

But most asteroid commodities will only be marketable in a future where ambitious space-flight is a regular human activity; for example, extraterrestrial depots where spacefarers could top off their fuel tanks and water supplies while on long trips. If there are no such trips, there is no business model.

Similarly, the idea that common metals will be useful in space is predicated on a manufacturing industry that is building space stations and spacecraft in orbit. Assembling structures in space, rather than launching them from Earth, is appealing because it avoids the cost of launch. A lack of orbital construction or the advent of cheaper launch systems could obviate this business.

If space stations are growing food for full-time residents, they could become lucrative markets for more than iron and steel. Asteroid-derived nitrogen and ammonia would be in demand for fertiliser. Such industries are vital if humans are to make their home in space. "We're talking about technologies that break the umbilical cord to Earth," Lewis says.

Planetary Resources' scheme is more than a business plan, it's a rose-coloured blueprint for supporting space exploration. Its existence speaks to humanity's drive to explore, to spread, and to support the most audacious of our dreams.

PM

REACHING FOR THE STARS

Budding rocket scientists have a blast

> STORY AND PICTURES BY SEAN WOODS

Space, to borrow a phrase from *Star Trek*, is the final frontier. However, without highly skilled individuals capable of pushing technological boundaries, humanity is never going to move off this rock we call home. Fully aware of this, two student teams from the University of Cape Town build and launch their own mock satellites. While adopting completely different approaches, they endeavour to achieve the same result.

A half-century since its inception, space travel may still seem like the stuff of fantasy; but designing a satellite and launching it into space has to deal with real-world issues such as size, weight, time and budgetary constraints. Juggling these often conflicting variables – not to mention co-ordinating a multi-disciplinary team of specialists – to produce a successful outcome can get complicated. No wonder it's called rocket science.

Without satellites, we wouldn't have a global positioning system. Weather prediction would be even more imprecise than it already is, and we'd have none of those breath-taking images taken from space that highlight the beauty of our planet. To say we're on the cusp of something truly phenomenal, with many yet-undiscovered benefits from space programmes still to come, would be an

understatement. So it stands to reason that we need to invest in bright young minds, providing them with solid foundations to push our understanding of space technology into realms as yet unfathomed.

Fully aware of our dearth of local expertise, the University of Cape Town (UCT) has initiated an Introduction to Space Technology course, specifically geared towards senior undergraduate and first year postgraduate students keen on pursuing careers in this exciting field.

Astrophysicist Dr Peter Martinez, chairperson for the South African Council for Space Affairs (SACSA), presents the course. "This is such a specialised area that there are very few space technology experts in any of our academic institutions, so my aim is to foster good communications between universities, industry and government research institutions," he says. "This course is a perfect example of this type of synergy."

Now in its fourth year, the course incorporates both theory and practice, giving students an holistic taste of what to

expect once jettisoned into the workplace.

Guest speakers, all international experts in their fields, lecture on a diverse range of topics from space weather to liquid and solid rocket propulsion systems, space law, orbits and astrodynamics, space debris, telemetry and much more. To round things off nicely, American space tourist Dr Gregory Olsen, who spent time on the International Space Station in 2005, delivered a lecture this year titled *From Entrepreneurship to Spaceship*.

On the practical front, the students, drawn from UCT's various departments, are separated into teams. The plan is twofold: first, it groups different skills and interests together, giving them the collective ability to problem-solve. Secondly, and just as importantly, it gives them exposure to the kind of group dynamics typically found in multi-disciplinary technical teams.

Mimicking reality

The teams have to design and build their own CanSat, a small, pseudo-satellite that incorporates many of the components



Team NitiKnight's William Tipping-Woods demonstrates their deployable CanSat design that uses Nitinol wire to fold back and then release its wings.





Top: A flawless launch.
Above: Onlookers help to rig the rocket for launch.
Main: The rocket's designer, SALT's Ockert Strydom (right), gets ready to blast both teams' CanSats into the sky.





Team NitiKnight's William Tipping-Woods and Andrew Nicol work on their CanSat design. To test its viability, they used 50 helium-filled party balloons (attached to a fishing rod) to get it airborne before releasing it over one of UCT's sports fields.



found in the real thing. Then they get it to perform various autonomous tasks.

Each CanSat must have the maximum weight (350 grams) and dimensions of a standard cool drink can, hence the name. Inside, the teams have to pack in enough hardware and electronics to collect live telemetry (acceleration, velocity and altitude) data and transmit it to the ground in real time, as well as develop their own ground systems to receive the transmitted data. The data also had to be recorded onboard for downloading at a later stage.

Once ejected from the launch rocket's payload bays at an altitude of approximately 1,1 km, the CanSats have to navigate themselves autonomously to a predetermined location on the ground. The examiners, in this case Martinez and the head of telemetry at Denel's Overberg Test Range, Japie Venter, pick the location just a few hours before

launch. That forces the teams to program the necessary co-ordinates on the fly.

How the CanSats arrive at their destination depends purely on the ingenuity of the teams. They can deploy either glider or parafoil configurations, even fall from the sky, hit the ground and drive; whatever they do, they just have to get there.

"This course highlights the difference between engineering something on paper and making it work," explains Martinez. "The students end up learning lessons they didn't even realise they'd learnt from an experience like this."

This year, two three-member teams took up the challenge:

Team Excelsior, made up of electrical engineering's Dayne Kemp, maths honours student Lior Neu-Ner and mechatronics specialist Geoffrey Kilpin.

Team NitiKnight, comprising electrical engineering students Andrew Nicol (who,

incidentally, already has a computer science degree under his belt) and Karthik Rajeswaran, along with William Tipping-Woods who's busy with his Master's in mechanical engineering.

Both teams were given a month and a measly budget of R3 000 to complete their projects. Apart from the seemingly impossible timeframe, their funds – expected to cover everything – had to be stretched to the limit. "The short timeframe and small budget given to the project are by design," says Martinez. "We want them to become aware of the pressures involved when preparing for a specific launch window, as well as the very real financial constraints all projects face in industry."

Team Excelsior

Adopting the KISS (keep it simple, stupid) approach, Team Excelsior opted for a parafoil design to steer their CanSat to the landing site. Kemp explains: "We eliminated the glider option because of our lack of experience and time constraints. Instead, we chose a small parafoil because they're so simple to control. All you need do is pull one line in while releasing the other side, something we could accomplish using one actuator. And, by buying one from a hobby shop, we gave ourselves more time to concentrate on the electronics. All we did was go for the most logical, simple method available, really."

However, things are rarely as simple as they initially seem. To steer the parafoil, the team ended up having to write some pretty intense algorithms. "We soon discovered that, when we pulled the parafoil's right chord to turn right, for example, we had to stop the momentum early by applying a little left on the actuator, otherwise it would quickly oscillate out of control."

For the CanSat itself, they chose a laser-cut Perspex spine and circular ends (giving them plenty of space to mount the electronics and battery), and a cylindrical carbon fibre enclosure to protect and strengthen it. The main printed circuit board, mounted to one side of the Perspex spine, contained the actuator, 16 G accelerometer, gyroscope, magnetometer, pressure sensor and a 90 dB buzzer so they'd be able to find it if it landed in dense vegetation. An IMU (inertial measurement unit) analyses inputs from all the sensors to provide spatial awareness and orientation should anything go wrong with the GPS.

As for the GPS module, its circular circuit board was made by hand, and then



Team Excelsior's CanSat featured a carbon fibre outer shell, with its GPS module mounted outside the casing to ensure it received a reliable signal.



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Team Excelsior's Dayne Kemp and Geoffrey Kilpin prepare to receive data from their CanSat just before the launch.

positioned on top of the CanSat to ensure clear satellite reception. Says Kemp: "Carbon fibre isn't very permeable to electromagnetic waves, if we'd positioned the GPS inside the casing we wouldn't have been able to get a fix."

Team NitiKnight

Why do simple when you can do complex? Nicol explains: "There's no established way of doing this, so we wanted to do something that was completely novel and innovative. We wanted to push our own boundaries."

Inspired by the Mars rover's landing system, they wanted to create a deployable payload. Their first plan was to construct a quad-copter out of Nitinol, a memory alloy made from nickel and titanium. "We came across Nitinol wire and had no idea how to use it," says Nicol. "This project was a great opportunity for us to try something interesting with the stuff."

Unfortunately, after much research, they realised their "ideal" system was becoming way too complicated. So instead, they decided to build a glider, with Nicol concentrating on the electronics and Tipping-Woods working on the mechanical design.

Next complication: they soon discovered that it was nigh on impossible to fit the wing inside the rocket's payload bay, so it ended up another scrapped design. Fortunately, though, they had achieved one breakthrough: because they needed to keep weight to a minimum for the glider to fly, they were obliged to pack the same amount of electronics as Team Excelsior into a package weighing a mere 60 grams. "Technically, the electronics could have

fitted into a matchbox," explains Nicol.

With only one week left before launch and time starting to run out, they decided to do the tried-and-tested thing – that is, build an aircraft. However, controlling an aircraft autonomously is a complex affair, so Tipping-Woods fell back on the tried and tested: keep it as simple as possible. Using balsawood, he made its centre of gravity as low as possible and gave it high-mounted dihedral wings for extra stability.

Not wanting to give up their dream of a deployable system, they used Nitinol wire to connect the wings to the fuselage. Once their payload exited the rocket, the plan was for its folded wings (held in position at their tips by a band of paper connected to a small parachute) to spring into position to allow for stable flight.

Because they didn't want the flying controls to activate while the CanSat was still inside the rocket, they fitted a photo LDR (light dependent resistor) to tell it when it was outside. Only then would their system take over the autonomous tail and rear elevator controls. They also included an ultrasonic ranger so it could determine the distance to the ground and pitch up its nose just before landing – preventing it from ploughing into the ground.

Crunch time

Come launch day, the weather forecast wasn't promising. The first big cold front of winter had just hit the country, bringing with it heavy snow and flooding that forced the N1 and N2 national roads to be closed.

But no one was going to allow the lousy weather to detract from the occasion. Bundled up to keep out the cold and driving rain, both teams, along with a gaggle of enthusiastic supporters, waited for a break in the clouds over Denel's Overberg Test Range, situated near Bredasdorp in the Western Cape, for an opportunity to put their projects to the test.

While waiting, Martinez commented, rather pro-

phetically as it turned out, "Even if it blows up on the launch pad, both teams will have gained a tremendous amount of experience just reaching this point."

Finally, a break in the weather brought on a flurry of activity. After an impressive *whoooooosh*, the launch vehicle, accompanied by a billowing tail of exhaust gases, rocketed flawlessly into the sky.

Unfortunately, instead of reaching an apogee just over a kilometre high as planned, it levelled out at about 800 m.

Because of its shallow trajectory, the rocket's three parachutes didn't stand a chance. The momentum ripped all three off their attachment points, followed by the rocket and its two-CanSat payload plummeting groundwards in a trajectory that would have made an Olympian javelin thrower proud.

Later, while the two teams rummaged through the wreckage to see if anything was salvageable, Nicol deadpanned: "Oh well, and that's our final result!" Martinez was just as philosophical. "That's engineering for you. You invariably learn more from your mistakes than from your successes."

Neither team was put off by the experience one bit. In fact, both are keen to rebuild their projects and launch them again in their own time – just because they can.

Kemp, who is the chairman of UCT's South African Space Association (SASA) student chapter, would also like to throw down the gauntlet to other universities. "What we want to do is host an annual CanSat event. Apart from being loads of fun, it'll also be a great way for us all to compete against each other and create more awareness about space studies here at home."

● To find out more, visit SASA UCT's Web site <http://sasa.soc.uct.ac.za> **PM**



Both teams check to see if there's anything to salvage after the rocket ploughed into the ground with their projects still onboard.



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A BRIEF HISTORY OF ...

Fireworks

Once just simple incendiary devices, fireworks have become a spectacular staple of celebratory displays. Here's how humanity has lit up the sky through the ages.

BY AMANDA GREEN

200 BC

It starts with a big bang. Bamboo thrown on a fire in China explodes as air expands inside the reeds, and rudimentary firecrackers are born. Locals decide they should be used to scare away evil spirits.

AD 600 TO 900

Things get pyrotechnical when a Chinese alchemist combines sulphur, saltpetre and charcoal, and sets it on fire. The more oxygen-rich the saltpetre, the bigger the explosion. Soon the Chinese pack powder, rocks and metal into containers to make weapons.

1295

Marco Polo brings fireworks to Europe from the Orient. (Also: porcelain, jewels, spices and other less exciting items that don't go boom.)



1400 TO 1500

The Renaissance begets unparalleled advances in art, literature – and fireworks. The Italians launch projectiles and burn powdered metals and charcoal slowly in open tubes to create sparklers. Controlled fires

become de rigueur at coronations. Commoners miss out on the fun.

1605

Guy Fawkes was a member of a group of Catholic revolutionaries who planned to carry out the infamous Gunpowder Plot (in essence, by blowing up Parliament and everyone in it, including King James I). The plot was discovered just in time, and the conspirators were arrested (Fawkes and eight others suffered a rather messy end). Ever since, we have celebrated 5 November by building bonfires, lighting fireworks and (more rarely) burning effigies of Fawkes.

1635

John Bate publishes the four-part book series, *The Mysteries of Nature and Art*. In part two, he outlines how to create flying dragons, along with other fiery spectacles. Among those the book inspires: a young Sir Isaac Newton.

1730s

Powder to the people! In England,

fireworks shows become public spectacles for everyone to enjoy. Colonists bring them to the Americas, where they set them off on Independence Day 1777 and think, "Hey, maybe we should do this again next year".

1830s

Italian pyrotechnicians add colour to fireworks with chlorinated powder and metallic salts (strontium = red, barium = green, copper = blue, sodium = yellow). Using potassium chlorate as an oxidiser makes the hues brighter.

1966

Cherry bombs, first used as weapons during the American Civil War, are banned in the US. But until his death in 1978, Keith Moon, drummer of the Who, blows off steam – and blows up hotel toilets – with illegal cherry bombs.

1956 (AND BEYOND)

Introduced 56 years ago, with additional rules imposed by local authorities, South Africa's Explosives Act No 26 makes it unlawful to discharge any fireworks in any building, on any public thoroughfare or in any public place without written permission from the local authority. The law is especially tough on people who allow children to discharge fireworks, while the SPCA (among others) takes a dim view of the traumatic effects on animals.

1999

Disney World launches fireworks with compressed air instead of gunpowder at Epcot's pyrotechnic spectacular *IllumiNations: Reflections of Earth*. Disney is the largest US consumer of fireworks, making its theme parks the "happiest places on Earth" for American pyromaniacs.



2008

The Chinese Olympic Committee admits that CGI was used to enhance fireworks footprints that appeared to walk across the sky for TV audiences and fans watching the Beijing stadium's Jumbotron. The New York-based Grucci family, who created the actual display, is not amused.

2010

Pop singer Katy Perry releases the empowering single, "Firework", reportedly inspired by a passage from Jack Kerouac's 1957 novel, *On the Road*. **PM**

'THE ONLY PEOPLE FOR ME ARE THE MAD ONES, THE ONES WHO ARE MAD TO LIVE, MAD TO TALK, MAD TO BE SAVED, DESIROUS OF EVERYTHING AT THE SAME TIME, THE ONES WHO... BURN, BURN, BURN LIKE FABULOUS YELLOW ROMAN CANDLES EXPLODING LIKE SPIDERS ACROSS THE STARS.'



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Burning life	42 h**
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Luminous Flux	115 lm*
Batteries	3 x AAA 1,5 V

* Luminous flux (lumens) and max beam distance (meters) are measured when switching on with new set of fresh alkaline batteries. These are average values and may vary +/- 15% depending on type of chip and batteries.
** Average hours of burning life as measured in the least energy-consuming mode and until residual luminous flux amounts to 1 lumen.

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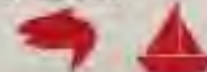
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LIFE

AT

THE

EPICENTRE

Earthquakes are inevitable, but very few people living near a major fault take steps to protect their families and homes. Preparing for the big one can mean the difference between safely riding it out – or losing everything.

The peeps were moving. It was Easter Day, 2010, and I was at a potluck brunch not far from downtown Los Angeles. It was characteristically sunny and warm, and many of the guests had settled into the host's backyard garden. I was one of a half-dozen people sitting at a wooden picnic table when the shaking began. At first I thought it might be nausea. I was four months pregnant and had already eaten one too many of the sugary marshmallow chicks. Then I saw that everything on the table was vibrating.

Earthquake.

Little about it was scary. In fact, the sensation was mildly pleasant, just a mellow undulation, like standing on a floating dock as a spent motorboat wake rolls through. In seconds, it was over.

Soon other guests filed out of the house. "Did you feel that?" people asked one another. A lot of them hadn't noticed a thing, but I was thrilled. After three years in LA, it was my first true earthquake. Phones were fished from pockets and purses and Twitter feeds consulted. This was the real thing, a 7.2-magnitude tremor that originated in Mexico, 10 kilometres beneath the Baja Peninsula. There was some damage near the border, but Los Angeles had been spared.

A few days later, my husband, Dan, and I were sitting in our living room when an aftershock hit. We briefly locked eyes, then turned our gaze to the darkened TV. We had recently bought our first flat-screen, and dutifully used cheap earthquake straps to secure it to the mantel above our defunct fireplace. They worked. The shaking stopped. Everything was fine.

THE PAST FEW YEARS have been turbulent ones for the planet. Earthquakes have caused massive devastation, killing 86 000 people in Pakistan in 2005; 87 000 in China in 2008; and close to





BY
KALEE THOMPSON

ILLUSTRATIONS BY RANDY ORTIZ

100 000 in Haiti in 2010. In the two highest-profile earthquakes of the past decade – the 2004 Sumatra quake and the 2011 Tōhoku event in Japan – most of the death and destruction were caused by a subsequent tsunami. Four of the 13 most deadly earthquakes in history have occurred since 2004 – a statistic that says less about Earth than about how humans live on it. Growing populations and dense urban centres create greater hazards from natural disasters. (Even the strongest earthquake poses little danger to a person alone in a field.) When major quakes strike, as they inevitably will, people-packed cities like LA are most vulnerable.

Long before I moved to California I knew that earthquake-probability maps show the Pacific Coast traced in red, reflecting the major fault lines that form where tectonic plates abut. But until recently, I hadn't looked into the specifics: seismologists estimate there's an 82 per cent chance that a magnitude-7 or greater quake will hit directly beneath Southern California in the next 30 years. Three-quarters of all US earthquake losses are expected to occur in the state, and experts' best-guess estimate is that damages will exceed R250 billion per decade on average.

Meanwhile, Americans have been reminded that earthquakes aren't purely a California hazard. In August 2011, a 5.8-magnitude tremor struck near Richmond, Virginia. That quake, felt from Georgia to Quebec, was the largest to hit the Southeast in more than a century.

Using new paleoseismic data and more complex computer-forecasting techniques, the US Geological Survey is refining risk estimates for places such as the Cascadia subduction zone off the Pacific Northwest coast, the Wasatch fault near Salt Lake City, and the New Madrid seismic zone, extending from southern Illinois into Arkansas, which experienced four magnitude-7 quakes back in 1811 and 1812. Of course, probabilities tend to have less impact than personal memory of actual events, and throughout the US, it's been a time of relative quiet. The last earthquake to cause significant havoc was the 6.7-magnitude Northridge quake, which killed 57 people and delivered more than R160 billion in damage to the Los Angeles area in 1994. That mild Easter Sunday tremor in 2010 turns out to have been the most powerful earthquake to touch Southern California in nearly 20 years.

The same month, Dan and I were in the process of buying our first home. To us,

the property was charming: a peak-roofed, light-filled house perched atop an ivy-smothered slope. We didn't mind the steep, uneven stairs that led to the front door, or the cracks in the flaking plaster and the concrete patio. For a house built in 1927, such scars seemed minor.

We were pleased to learn that the building had been bolted, the foundation attached to the wooden frame with a series of struts and bolts. The job wasn't to current building regulations, but overall it looked pretty good, our home inspector told us.

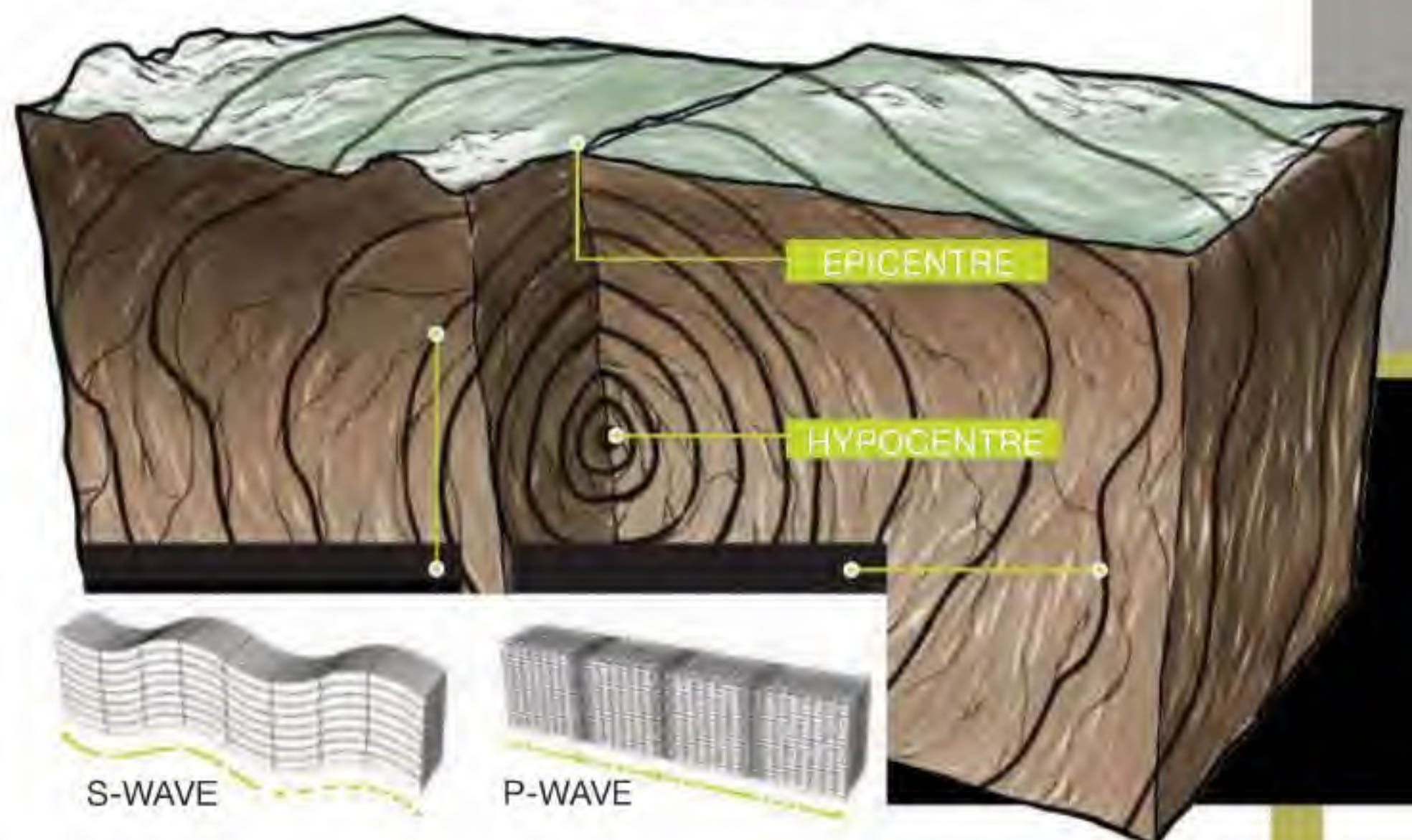
We reviewed insurance options. Earthquake insurance would more than double the cost of basic insurance. We had a decent idea of worst-case scenarios: friends had been "red-tagged" after Northridge, when authorities marked 1 600 homes as uninhabitable and forbade residents to return.

Still, what were the chances of that happening again? Of it happening to us? Looking more closely at the quote, I saw that the excess for our home would be more than R400 000. Justifying the decision to forgo earthquake insurance wasn't difficult. The house has held up for this long, we rationalised. Something truly catastrophic would have to happen to make that expense worthwhile.

STILL, EARTHLY HAZARDS HAD SEIZED my attention. In the past, I'd been exasperated by my East Coast family's concerned phone calls following news coverage of Southern California's forest fires. "That's nowhere near us! We're completely safe," I'd reassure them (though once we could see distant flames from our apartment's front porch).

Now, though, I was the one worrying. The financial gamble of homeownership was part of it. The other was my son, Otto, who was born a few months after we moved into our new home. For the first time, I compiled a household earthquake kit, adding a week's worth of extra diapers, wipes and baby food to the stockpile of water, torches and first-aid supplies. I made room in the boot of our hatchback for a basic survival kit including energy bars, a fire extinguisher, sneakers, more diapers and a couple of 10-litre water containers, and

EARTHQUAKE MECHANICS



studied the emergency-shut-off directions for our gas line and water heater.

When the 9.0-magnitude earthquake, tsunami and nuclear disaster struck Japan in March 2011, Dan and I half-jokingly debated the pros and cons of stocking up on plastic sheeting and duct tape. Nuclear disaster planners recommend a shelter-in-place approach to radiation plumes. But our house has neither a real basement nor any windowless rooms. Maybe sealing off our draughty, old-fashioned swing-open windows would help?

Did we think dangerous fallout from the Fukushima Daiichi power plant might actually stretch across the Pacific? (Some members of an online moms' group I lurked in were convinced it was already happening.) Or were we more concerned about a similar "unforeseen" disaster at the San Onofre nuclear power plant 100 kilometres to the south? (News that it had been built to withstand a magnitude-7 earthquake suddenly didn't sound so impressive.) I'm not really sure. Both of those possibilities seemed outrageously unlikely, yet it was foolish to completely dismiss them. What I knew to be true was that radiation exposure poses especially high risks for small children. Otto was six months old.

When I saw a flier advertising a free emergency-preparedness class at the local library, I signed up. Over seven evenings, I sat between an elderly Japanese couple and a row of ageing hippie types as a firefighter schooled us on various disaster scenarios. We practised triage and first aid with what struck me as a somewhat lofty idea that when the big one hit, all of us – informed, diligent citizens that we were – would be providing crucial backup to first responders. Gory videos of car crashes and building collapses were the backdrop to discussions on how to treat head trauma (the No. 1 earthquake injury, our instructor said); how to make or find potable water when utilities are cut off (mine your water heater); and the California laws governing defecating in your own yard (illegal! my live-free-or-die New Hampshire relatives would be outraged). But I also had a more fundamental question about earthquakes: what were the odds I'd ever have to use these skills?

IN MORE THAN 30 YEARS at the California Institute of Technology, seismologist Tom Heaton has developed a reputation as something of an earthquake maverick, with expertise in both geophysics and engineering. He's a large man, with suspenders that stretch over his neatly pressed dress shirt and a soft, jowly face framed by a cloud-like crown of white hair. I'm hoping Heaton will provide some straightforward facts to help me frame our mutual earthquake

EXCESSIVE PRESSURE BETWEEN TECTONIC PLATES can cause them to slip and the ground to rupture. A series of seismic waves emanate from this hypocentre (as opposed to the epicentre, the point directly above that on the surface). Fast-moving primary, or P-waves, reach seismograph stations first, and like lightning preceding thunder, can provide valuable seconds of warning before the real shaking begins. P-waves cause rock to expand and contract as they pass through it. Secondary shear, or S-waves, displace material at right angles to their path and reach the surface later. They undulate along Earth's crust much like ocean waves and, as a result, they cause the most damage.

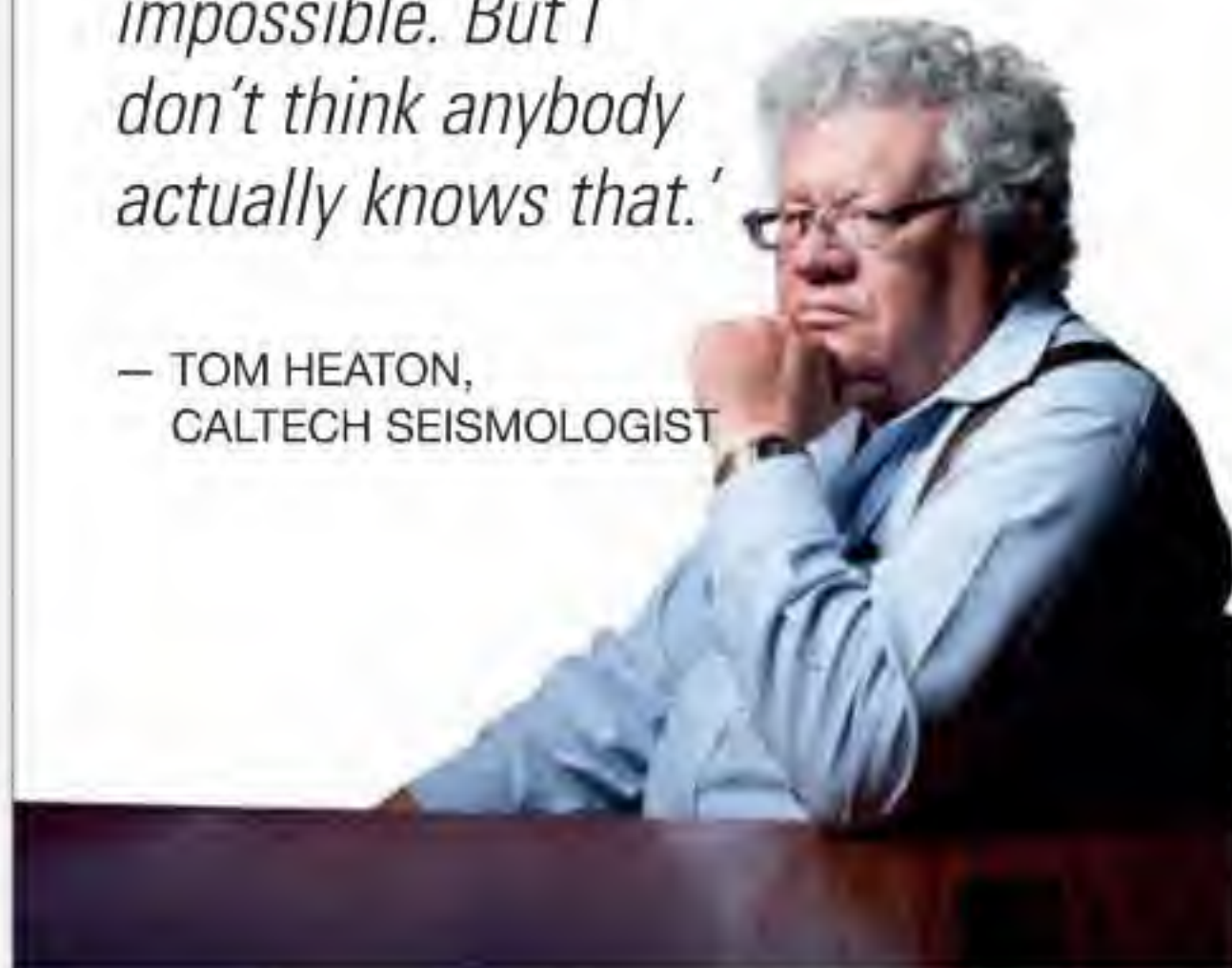
*'Losing a major city
(to an earthquake)
would be hard for
somebody to even
imagine today.
Maybe some people
would say that it's
impossible. But I
don't think anybody
actually knows that.'*

— TOM HEATON,
CALTECH SEISMOLOGIST

risk. Instead, he leans back, obviously bemused by a question he's heard too many times before. "It's almost like asking how big is the risk from wars, how big is the risk from epidemics," Heaton says. "When we look at the statistics of earthquake problems, they're the kind where things that don't happen very often end up being incredibly important."

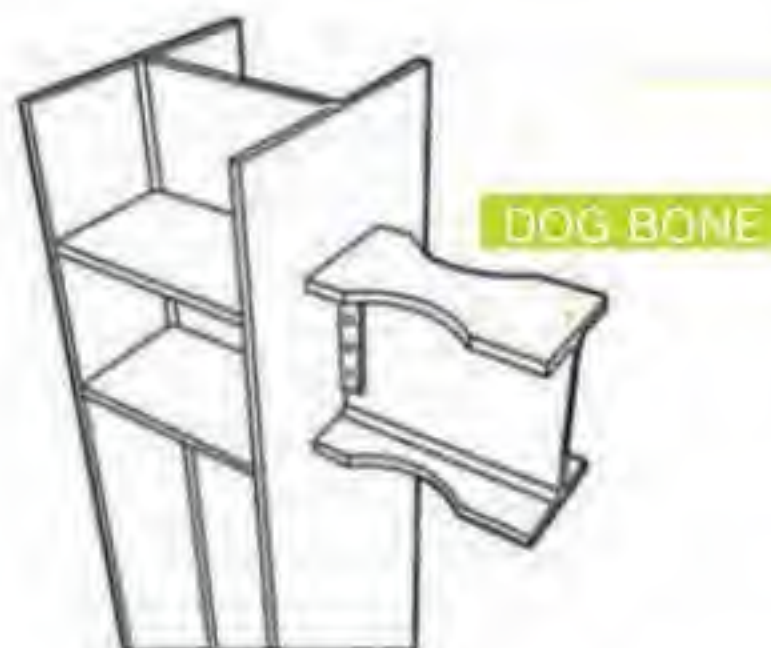
Recent US seismic history doesn't give us any real clues as to what lies ahead, Heaton says. "In the last century, we've only had deaths in the hundreds. But if you look at 1906, the largest city in the western US was basically wiped out by an earthquake. Losing a major city would be hard for somebody to even imagine today. Maybe some people would say that it's impossible. But I don't think anybody actually knows that."

I ask Heaton what he thinks about my earthquake-insurance rationalisation – that my house has endured 80 years of shaking, and so can probably hold up for the four or five more decades that Dan and I will be around. He smiles. "Oh no, that doesn't really tell you anything," he says. It's no accident that earthquake-probability forecasts use a 30-year time frame, the same as the typical home mortgage. Heaton has been intimately involved with the complex number-crunching responsible for those statistics, and although the figures



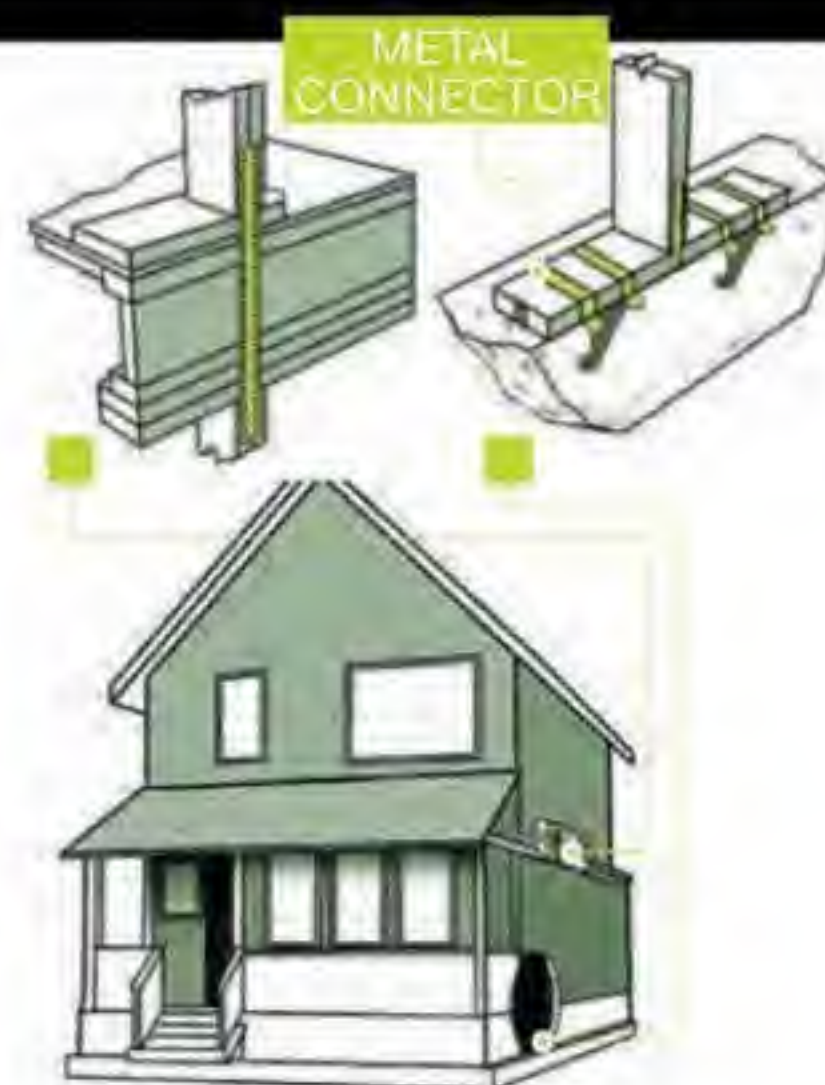
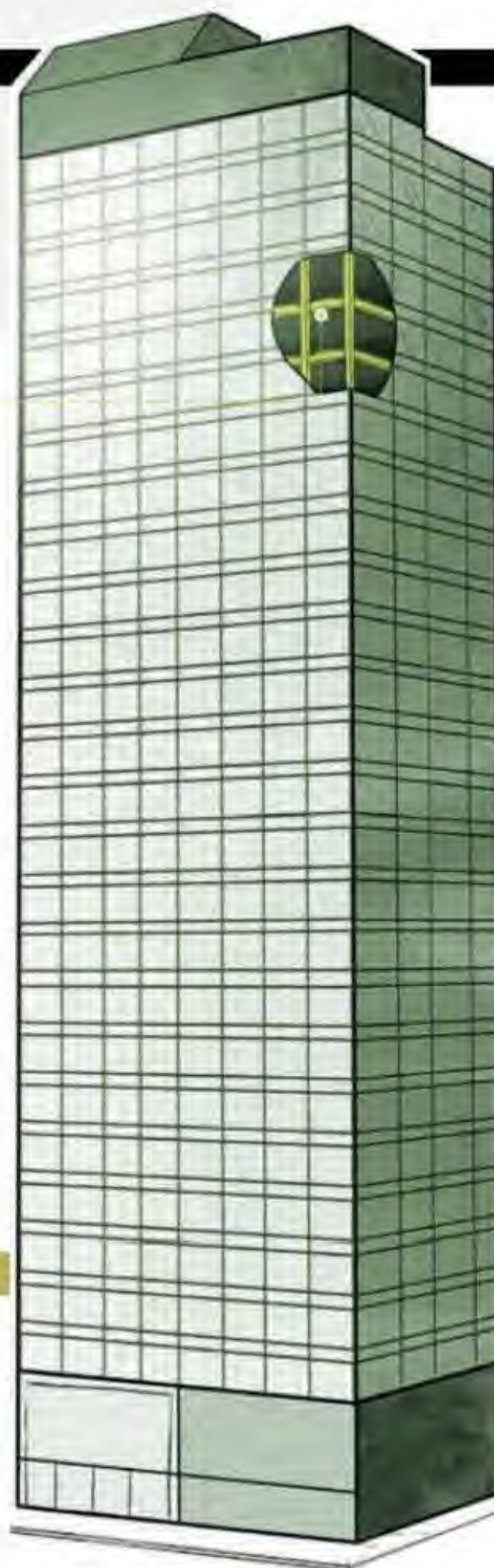
IMPROVE YOUR EARTHQUAKE IQ

Building regulations were not always so rigorous, especially in earthquake-prone areas. Here's how to eyeball the risk posed by various structures.



A SKYSCRAPER'S CREDENTIALS AREN'T VISIBLE

from the sidewalk, but you can rest assured that steel is more pliable than brick or concrete, and that modern skyscrapers are subject to stringent seismic standards. "You don't just want to build something that's stronger; you want to be able to control where it gives," engineer Aaron Reynolds says. To do that, architects add "dog bones" to the frame; areas of reduced width on the building's steel beams. These weak zones absorb shaking, diverting strain from its welded joints. If you're inside a high-rise during a quake, stay put; you run a greater risk of being hit by debris outside.



ONE OF THE SAFEST PLACES TO BE

during an earthquake is inside a well made wood-framed home. Metal connectors join the floors and walls in newer houses; older ones have often been professionally retrofitted or bolted. This creates what's called a continuous load path, in which the frame of the house moves as a single unit during tremors. Hardware should also connect the foundation and mudsill to wall studs.

undoubtedly help citizens evaluate risk – and engineers set building standards – he is the first to admit that the forecasts are perplexingly vague.

"I've fallen asleep a hundred times with those numbers," he says. "We argue and arm-wrestle. There's a million compromises." A magnitude-7 quake, after all, may be a neighbourhood-flattening jolt or just another fun party story, depending on where and when it comes.

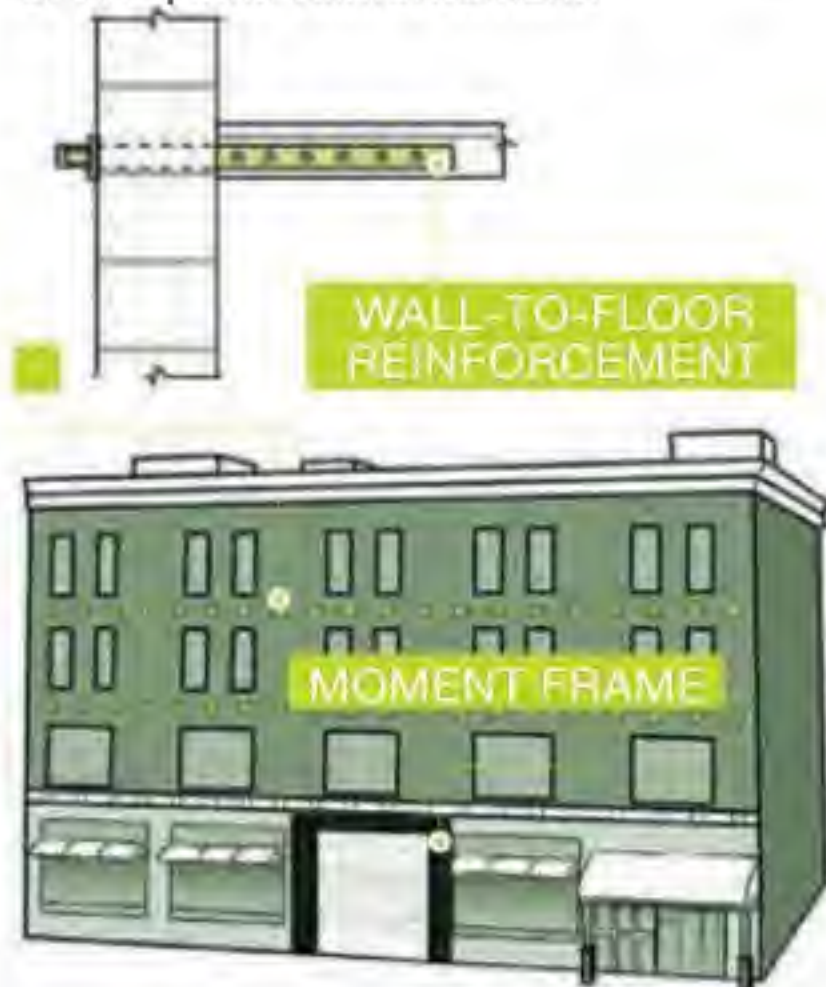
Heaton has raised three children in a home built in 1910. He doesn't have earthquake insurance either. He used to, up until 1991, the year the 5.6-magnitude Sierra Madre earthquake damaged his home. "It broke some foundation; it destroyed the chimney," he says. "By the time it was done, it caused several tens of thousands of dollars in damage, and earthquake insurance paid for that. It was a good deal." Since then, the price of earthquake insurance has gone up, along with excess payments. Heaton and plenty of other Californians calculated that it made more sense to invest in upgrades that would protect against future quakes than to pay a skyrocketing monthly premium.

Though it's our homes we fret about most, they're usually the least vulnerable – at least single-family, wood-frame houses like the ones Heaton and I own. "Wooden houses are extremely resilient to earthquake shaking. It's almost unheard of that they actually collapse," he says. Far more dangerous are unreinforced brick structures and what engineers refer to as nonductile concrete buildings. Had the Northridge earthquake occurred during the workday rather than at 4:30 am, studies concluded, there would have been 20 to 30 times the fatalities.

The same principle will likely apply when the inevitable big one strikes. A study that simulated a 7.9-magnitude rupture on the San Andreas fault (a repeat of the 1906 San Francisco quake) calculated that 8 000 people would be seriously injured and 1 800 killed if it occurred at night. If it struck during the day? Expect 12 500 injured and 3 400 dead.

NOT LONG AFTER THE JAPAN DISASTER, I fell into conversation with the wife of a University of California, Los Angeles, seismologist at a friend's housewarming. Her husband, the woman told me, had been part of a study that identified

INTENSE SHAKING CAN CAUSE OLD MASONRY WALLS to crack, crumble and collapse. Brick buildings can be strengthened with concrete and have steel “moment frames” installed around storefronts. Often, steel wall-to-floor reinforcements are visible from the street, where sandwich-sized metal plates delineate the line between storeys. While such retrofitting work is often mandated by building regulations, there are still old brick buildings with little or no quake reinforcement.



WITHOUT SUFFICIENT METAL REBAR, concrete buildings are prone to pancaking. The risk is often higher in a building with a “soft” first storey – one with high ceilings and multiple openings. Though rebar isn’t visible, other reinforcement is: contractors adhere carbon fibre to concrete walls and posts. “It looks like somebody glued on a hessian bag,” Reynolds says. You may also see shear walls bracing the soft first storey.



A BUILDING WITH BASE ISOLATION rests atop a series of flexible rubber cylinders; these act as a suspension system, turning violent jolts into subtle vibrations. The approach is the gold standard for hospitals, schools and buildings that contain computer servers, refrigerated medical samples and other valuable equipment. Such buildings are usually surrounded by a concrete moat at street level. Look for a tiny gap in the pavement near the building’s exterior walls.



the most collapse-prone buildings in LA. Maps existed, but city officials didn’t want the public to know about them. In the weeks that followed, I often found myself examining buildings as I drove LA’s surface streets, looking for signs of seismic reinforcement. In restaurants and shops, I’d try to guess the age of brick and concrete, wondering if I might be lingering over a sandwich inside a structure on the secret danger list.

Eventually I tracked down the study in question, as well as one of its lead authors, Mary Comerio, a professor of architecture at the University of California, Berkeley. In her view, the building list wasn’t quite the scandal I’d imagined over my second glass of wine. It’s a research database that was never meant to be public, she tells me. The effort is part of a much larger project tasked with figuring out how to classify concrete buildings by their risk level.

The number of potentially hazardous buildings in Los Angeles is small compared with that of many other cities, Comerio says. “Los Angeles has had a very aggressive public retrofit programme. Every public building in the city has either been retrofitted or replaced.” Because of what she calls LA’s big adaptive re-use programme (also known as the downtown hipster invasion), lots of warehouses have been converted to residential lofts; planning regulations requires that such change-of-use conversions be seismically retrofitted. It turns out that Los Angeles’ future-oriented, growth-focused character makes it a safer place to live. “Los Angeles, frankly, tears down more buildings than a city like

San Francisco,” Comerio says. The latter has about 3 000 nonductile concrete buildings, twice the number in LA.

I still wondered why the inventory couldn’t be made public. When the research is complete, it will go into an open database. The building addresses, though, will be stripped out. “There are privacy issues,” Comerio says. “The minute it gets in the public realm, somebody is going to say, this is a list of dangerous buildings. That’s not what we’re saying; we’re saying this is a list of buildings we’re studying.”

Heaton had been less politic when I posed a similar question to him at Caltech: say you wanted to rent an office space in downtown Los Angeles. Is there a database that could help you identify which buildings are more or less safe? “No, you’re toast. You’re hosed,” he said. “There should be, but the politics of it are such that nobody has been able to push that through.”

Determined to improve my own assessment skills, I meet seismic engineer Aaron Reynolds in the lobby of the Walt Disney Concert Hall. Reynolds’s firm designs hospitals and schools and retrofits older buildings for seismic safety. As the result of improved

building regulations, it's typically not the primary structures that are the problem these days, he tells me. In recent decades, nonstructural damage, such as broken ducts and water pipes, has been more costly.

"I think there's a lot of confidence that (newer) buildings are going to perform fairly well," Reynolds says as we stand on the sidewalk beneath Frank Gehry's glimmering suspended-metal sails, gazing towards the compact cluster of downtown skyscrapers. "Collapse is just unacceptable."

We walk a few blocks to Temple Street and the city's fortress-like Roman Catholic cathedral. Reynolds stops a short distance from the exterior wall and points out a small gap in the pavement; it marks the edge of the narrow concrete moat surrounding the building's base. He makes a crude sketch on his iPad. The monolith rests on rubber cylinders known as base isolators, which act as a suspension system for the entire structure. During an earthquake, the isolators will absorb most of the energy.

The moat of concrete is designed to shift as needed – a metre or more – to give the building room to move. "Everybody

jokes about the drunk person in an accident; he's the one who doesn't get hurt," Reynolds says as the cathedral's bells begin to chime. "It's the person who's not drunk who ends up being injured because he stiffens up." A building is similar. "Stiff buildings absorb a lot of earthquake energy. With the isolation system we make it soft."

IN THE AFTERMATH OF THE TÔHOKU DISASTER, I kept hearing how Japan had the most advanced earthquake-early-warning system in the world. Information from a vast network of sensors automatically stops trains, shuts down utilities, and sends text and e-mail alerts to citizens soon after a significant quake begins. The lead time is typically just tens of seconds, the time between a fault slipping and the ground waves hitting population centres. But that's enough to save lives.

Scientists have talked about installing an early-warning system in California for decades, but the political will is lacking. It may be that society still holds out hope for true prediction, a word I find causes most seismologists to take a deep, nerve-calming breath.

Despite reports of prescient runaway pets, we remain unable to predict specific seismic events. Early warning is our best hope, but experts are pessimistic that the funding (more than R600 million) will materialise before another big quake hits. "If you look at the systems in other countries, they're generally a result of a killer earthquake," USGS seismologist Doug Given says. "The Mexican system resulted from the '85

PLAN, PREPARE, SURVIVE

Preparing for disaster is on lots of people's to-do lists. But less than one-fifth of households compile an emergency kit sufficient for a large-scale catastrophe or practise for one. Here are tips for riding out a quake safely.

BEFORE THE BIG ONE

Furniture: Use wall straps and Prestik to secure valuables and stabilise tall furniture. Head injuries caused by falling objects are a common trauma.

- **Emergency kit:** Companies such as Gerber sell kits, but it's often cheaper to compile your own. Use a weather-proof container, such as a plastic garbage can, to store supplies, including a battery- or hand-powered radio (some double as cell-phone chargers), flashlights, spare batteries, canned food, a manual can opener, first-aid supplies, and plenty of heavy-duty trash bags. Also keep photocopies of vital documents and prescriptions and a few hundred rand in small bills on hand.

Water: Estimate 5 litres per person per day for at least 10 days, and store the water separately from other supplies.

- **Bedroom:** Keep shoes and a torch near the bed. Lacerated feet were the most common injury during California's Northridge quake. Use closed-loop hooks for framed art and avoid hanging anything heavy above beds.

- **Kitchen:** Use cabinet latches to keep glassware from toppling out and shattering. Avoid storing ammonia, bleach or hazardous supplies on high shelves where they could spill.

- **Cellphone:** If you use Facebook or Twitter, begin following local emergency service agencies now. In recent disasters, social media sites have been the best source of information.

Utility room: Use metal straps to secure your hot water heater to the wall. Keep fire extinguishers where they're easily accessible.

AFTER THE BIG ONE

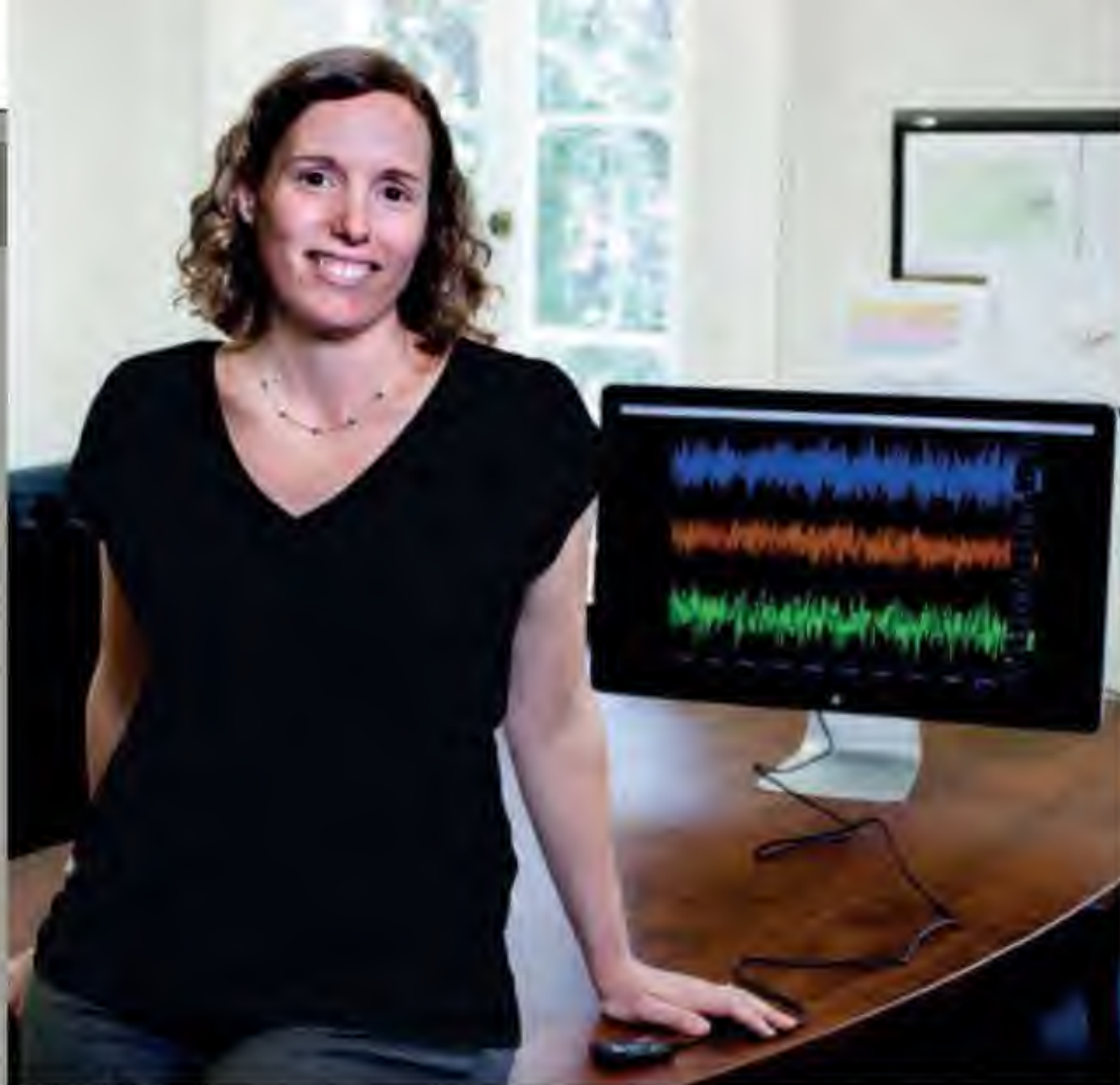
Wall phone: Landlines will be more reliable than cell service (though you may get text messages to go through even when calls won't). All family members should know the number of one out-of-town contact who can relay that everyone is okay.

- **Utilities:** Turn off water, electricity, and – if you smell a leak – gas. Fire is a real danger during the aftermath of an earthquake, when firefighters will likely be overwhelmed with other calls. Put a spanner inside a plastic bag, tape it just above your turnoff valve, and be

sure your family knows how to use it. If there's no evidence of a leak, however, leave the gas on. A functioning stovetop will be helpful if the power remains out for an extended time.

- **Backup H₂O:** The typical water heater contains 200 litres of potable water. The water in your toilet cistern is replaced after each flush and is also generally safe to drink. Gone through that? Regular household bleach can make the dirty drinkable. Add 16 drops of bleach to 5 litres of dirty water, strain and sip.

- **Porta-Potty:** Using your backyard as a bathroom will likely get gross fast. Instead, line a bucket or your dry toilet bowl with a heavy-duty trash bag. Add a little cat litter. Go. Repeat. When full, seal the bag and store separately from your other garbage.



Seismologist Elizabeth Cochran specialises in earthquake physics. Her Quake-Catcher motion sensors attach to home computers, turning them into a network of seismic stations.

earthquake that killed about 9 500 people. The Japanese system was the result of Kobe, which killed 6 400 in 1995. It's our hope that a bunch of Americans don't have to be killed before we build one."

Elizabeth Cochran's office is a 5-minute walk from Heaton's on the Caltech campus. Cochran invented the Quake-Catcher Network, a citizen science project in which thousands of people attach matchbook-sized sensors to their desktop computers. When many sensors in close proximity detect similar shaking at the same time, it's likely a real quake rather than random jostling. The day before my visit, there had been a 4.0-magnitude earthquake north of San Francisco; within 8 seconds, Quake-Catcher data pegged it at a fairly accurate 3.7. "The idea is that once, or if, it's found to be reliable, this could feed into an early-warning system," Cochran says.

After an earthquake, seismologists create shake maps that show the strength of the ground motion in different areas. "Right now those are highly interpolated," she says. "There are stations 50 kilometres apart and you're essentially guessing the ground motions in between." A vast network of Quake-Catcher sensors could add valuable resolution to those maps, identifying where to send firefighters, EMTs and transportation inspectors first.

I leave Cochran's office with a sensor of my own. Over the next few weeks, I work on my family's earthquake kit, stashing several extra 25-litre water containers in the backyard. I rearrange the furniture in Otto's bedroom so that his crib is no longer next to the pane-glass windows.

I also call two different retrofitting specialists to take a closer look at that ad hoc bolting job beneath our house. Contractor One seems genuinely impressed by the work and tells me that if it were his house, he wouldn't do anything more. Contractor Two, a well-respected local named Greg Sylvis, has specialised in retrofitting for three decades. He is more critical.

"A lot of times they'll just do the part you can see from the door," Sylvis says as he pulls on kneepads, a headlamp, and a face mask, then shimmies into the 30-cm-high crawlspace at the rear of the house, over soil littered with ancient bottles and rodent droppings. He finds no shortage of hardware, but much of it is extraneous, installed on interior posts, which won't help in an earthquake. The bolts could crack the wood like a log splitter, Sylvis says; newer jobs use clamp-like bolting instead.

The plywood that lines the cripple wall, which transfers strength from the foundation to the floor, is 3-ply, whereas 5-ply is required in permitted jobs. More concerning, the wall doesn't fully reach the floor. A nail gun was used to secure the plywood to the framing and the nailheads are recessed, increasing the likelihood that the nails would rip through the wood during a tremor. "It looks like a responsible contractor did it," Sylvis says. "But that doesn't mean he did a good job." Is it enough? I ask. His answer sounds all too familiar: "It's a lot better than nothing."

It will cost roughly R50 000 to rebolt the house, so that upgrade remains on our to-do list for now. But in most ways we've become well prepared, especially compared with many Californians. When a violent windstorm knocked out power last December, Dan, Otto, and I were in good shape. We had lanterns and head-lights, batteries, an adaptor to charge our phones in the car – and Twitter accounts, which proved to be the best way to get information.

While friends' panicky Facebook posts talked of evacuating to the Valley or West Side beach communities, Dan was uploading cute pics of Otto eating canned ravioli by lantern light. What if the free-ways were closed, I wondered. The supermarkets shut down. ATMs out of service. This windstorm was nothing when stacked up against what a big quake could deliver.

"We live in a world that has things we don't understand very well," Heaton says. "Does that mean we throw up our hands and just say it's inevitable, that we're going to die anyway?" No. It means we design buildings to make them less vulnerable. We prepare our homes and families to ride out calamities. And we take comfort in the fact that by preparing for the worst, we can maximise the chances that when disaster comes we'll be among those ready to offer help, rather than those who need it.

See overleaf for a South African angle →



The Ceres-Tulbagh earthquake. The most destructive earthquake in South African history struck the Ceres area in the Witzenberg Mountain range on 29 September 1969. Its magnitude was 6,3 on the Richter scale. Shock waves were felt as far as Durban (1 175 km). The earthquake was followed by a number of aftershocks, the most severe of which was on 14 of April 1970 (5,7). Here the devastation is clearly visible on these buildings.

Die Burger/Gallo Images

SOUTH AFRICA: TIME FOR A SHAKE-UP? BY ANTHONY DOMAN

A LITTLE AFTER 10 o'clock on the night of 29 September 1969, I stumbled sleepily down the passage wearing my pajamas and what my father tells me was a quizzical look on my face. "I think we're having an earthquake," I said. I clearly had a gift for stating the blindingly obvious.

With the ground heaving uncomfortably, the family hot-footed it out to the garden of our home in Wetton, on the Cape Flats. It felt eerie, everyone being outside at that time of night. Lights were flickering on, panic was setting in and uncertainty was everywhere.

And then the earth moved, sickeningly, once more.

But that was nothing compared with just a hundred kilometres to the northeast. Tulbagh, nestled in the Winterhoek mountains, was near the earthquake's Ceres epicentre. Townsfolk thought the end of the world had arrived as the 6,3-magnitude quake rumbled, roared and sowed devastation – taking a dozen lives and leaving half the town homeless. When the aftershocks had abated, the town was left in ruins and many buildings had to be demolished.

Today, a restored Tulbagh bears few visible scars. And it's all quiet on the earthquake front... for now.

Africa, fortunately, has not been subjected to the earthquake devastation on the scale seen in parts of the world such as south-east Asia, the US West Coast and Haiti in 2010. The continent's worst disaster of this sort

cost 15 000 lives in Morocco in 1960.

What is the potential right here in South Africa? Depending on whom you believe, we're in for a *really* big one... or we could wait a while.

The south-western Cape is a higher-risk area for big earthquakes than the rest of the country. Cape Town – and the Koeberg nuclear power station – lie close to the Milnerton Fault, scene of an estimated 6,3 earthquake in 1809. Seismic activity maps for Southern Africa also show hot spots clustered around Ceres in the Western Cape, Koffiefontein in the Free State, the Witwatersrand and Lesotho. Mines make the Witwatersrand prone to more frequent (but smaller) events. In the past year, tremors measured from 4,0 to 4,3 have been felt in Klerksdorp, the Karoo, Swaziland and the Southern Cape.

The likelihood of a big quake has increased with the spread of the East African Rift fault-lines, says Dr Chris Hartnady of earth sciences consultancy Umvoto Africa. Hartnady has called for greater earthquake awareness and planning so that we can cope better with disasters.

Local building regulations have been beefed up in recent times to ensure quake-resistant construction, particularly in Cape Town. Although South Africa is not regarded as earthquake country according to the Southern African Institute of Steel Construction, the new loading code stipulates that seismic actions need to be taken into account in design

much more often than in the past.

That came into sharp focus last year when a 9,0 magnitude earthquake caused a crisis in the area around Japan's Fukushima nuclear plant. Eskom rushed to allay fears, telling Parliament that Koeberg's design was more advanced and safer than the Japanese plant's and could withstand a 7,0-magnitude seismic shock.

Then again, a 2010 analysis by risk management specialists Aon Benfield and the University of Pretoria into potentially the country's biggest financial loss says that South Africa's big earthquakes occur infrequently. Their report, *South Africa Spotlight on Earthquake*, says it helps set the record straight regarding hype around predictions of a Haiti-scale scenario for Cape Town and Durban.

The report analyses selected seismic events that occurred between 1620 and 2006 within a 300 km radius from Milnerton. It concludes that an earthquake of magnitude 6,0 up to a maximum of 6,87 can be expected to occur once in 300 years in the Cape Town area. The resultant damage in the Cape Town CBD would be categorised "ruinous".

Although a magnitude 6,3 quake occurred in the 1930s at St Lucia, about 220 km north of Durban, South Africa's largest port city is at no great risk. The likelihood of even a magnitude 5,0 event causing significant damage is estimated at once every 735 years.

PM

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SO YOU BOUGHT A NEW TV... NOW WHAT?

How to get stereoscopic content without overhauling the rest of your home theatre.

> BY GLENN DERENE

You may, in the next few years, purchase a 3D TV and not even realise it. In 2010, the first wave of 3D TVs hit the market with much fanfare, but customers largely yawned; the sets sold at a premium, stereoscopic content was limited, and the glasses required to view 3D were complicated, uncomfortable and expensive. Tech pundits declared 3D TV stillborn. But a funny thing has happened in the past two years: a growing number of manufacturers have started to integrate 3D functionality into their sets as a matter of course. What was once a premium option is becoming the norm.

Now, just because your new set has 3D functionality, that hardly means you have to use it. I expect most 3D sets will spend the majority of their time displaying flat video, as most 3D sets are also no-compromise 2D sets. But leave a bunch of glasses splayed out on your living room coffee table and family members are bound to get curious. What can we watch with these things? Is there a way to get a little stereoscopic entertainment without shelling out a fortune for discs and extra components?

EQUIPMENT

Before we can answer the question of what to watch, it's worth asking: do I have the right equipment to watch 3D? For sure, you've got the TV, but if it were up to the electronics industry, the purchase

Photograph by Stuart Tyson

of a 3D TV would trigger a secondary buying binge of a 3D-capable Blu-ray player, a new home theatre system and maybe even a 3D video camera. The good news is that the price of 3D components has dropped significantly; the better news is that you might not need anything new at all. If you have a PlayStation 3, a firmware update in 2010 already upgraded your console to play 3D Blu-rays. And it's not even necessary to buy into the Blu-ray ecosystem at all because there are cheaper, easier ways to find 3D video. But you sort of get what you pay for.

3D FOR FREE

If you've purchased a 3D television, it is likely also an Internet-connected, app-enabled "smart TV", a bit of technological overlap that is convenient for the 3D dabbler. Such TVs are available from LG, Samsung, Sony and Panasonic. Internet connectivity opens up some options for viewing 3D content directly from the TV itself with no extra equipment. The home screen of the LG Infinia 47-inch set I recently purchased proudly promises instant access to 3D videos with its 3D World app. The app and its odd assortment of 3D clips are free, but require an account registration with LG. The randomness of the 3D offerings seems to defy categorisation, yet LG has attempted to construct channels: Japanese pro wrestling is the top selection in Sports, while a 2-minute tour of New York City shot entirely in Times Square is filed under Travel. (There is also at least one bait-and-switch – a listing for *The Mentalist* was not the CBS cop/psychic show but a short clip of a magician performing an act of comically inept levitation.) The shame of the 3D World app is that the footage actually sells the set short. It's not only terrible content, but the stereoscopic effect is awful, routinely giving the viewer double vision.

It's worth mentioning, briefly anyway, that the easiest way to experience 3D on any of these sets is by activating the now common 2D-to-3D conversion feature. Most TVs do a pretty good job of discerning foreground from background, but the effect is still a bit uncanny; 3D at its best uses depth to add a sense of visual context (think of the difference between the inside of a cramped lift and the inside of a big rail terminal), and the conversion technology seems to make all spaces feel equally deep.



ACTIVE SHUTTER GLASSES

Active and passive 3D TVs cost about the same, but battery-powered active shutter glasses are heavy and expensive. They do have better off-angle 3D viewing and show fewer jagged-edge artefacts.



PASSIVE POLARISED GLASSES

Passive glasses are used on some sets from LG, for instance. They are lighter and cheaper. Since the glasses are not as dark, passive sets appear brighter. In our tests, the 3D effect starts to break down when viewed off-centre.



Perhaps the best free 3D delivery vehicle is in hiding on many of these smart sets: YouTube. For three years, YouTube has cultivated a 3D channel for depth-perception enthusiasts. The channel allows users to upload and even edit footage in 3D, then display it in either anaglyph (red and cyan) or a format that conforms to 3D standards that televisions can understand. YouTube has worked with LG, Samsung and others to ensure that its apps on those manufacturers' HDTVs work, but no one has really promoted it. Much of the content is what you'd expect from a site that relies on the general public for content – 3D YouTubers seem to enjoy poking objects into the camera – but often the 3D effect, if not the storytelling, is surprisingly good.

3D WORTH PAYING FOR

The most expensive way to experience 3D entertainment on your new set is to buy 3D Blu-rays, and there's no denying that a properly mastered 3D Blu-ray movie or game looks fantastic. Hollywood studios have not yet given up on the concept of premium pricing for 3D movies, but it should provide some comfort that new-release 3D Blu-rays can be purchased on Amazon for far less than their R300-plus sticker prices. Even cheaper are 3D Imax documentaries, which can be had for less than R200.

Can't you just rent these things? Not through traditional routes. The best way to get 3D movies instantly is through Vudu, a streaming service that is built into many sets from LG, Samsung, Panasonic, Sharp and Toshiba. Vudu offers a decent selection of over-the-Internet 3D movies, including big releases such as *Tron: Legacy* and *Mission: Impossible – Ghost Protocol*. Many of the latest hits are for purchase only (although prices are around R180, which is typically cheaper than 3D Blu-rays).

Finally, in some parts of the world there's a small selection of content from television providers. Theoretically, 3D content can be sent for free over the airwaves; in practice, no one is doing that. But satellite operators are among those offering a limited selection of on-demand content and/or dedicated 3D channels (for example, ESPN 3D, 3Dnet). Special events, such as recent coverage of the Olympics, have been shown in 3D, and some service providers offer 3D on-demand movies. PM

Going it alone

Paddling a canoe solo isn't hard: just kneel and heel, then employ a rock-solid stroke.

> BY T EDWARD NICKENS



ROTATE YOUR CANOE, so what's normally the stern is up front. Kneel with your butt braced against the bow seat, just behind the centre of the boat.



USE A J-STROKE to correct the bow's drift away from the paddle side without killing momentum. Many people J-stroke ineffectively; see the instructions at right.



BOMB-PROOF J-STROKE



1. POWER / Plant the paddle blade in the water with the shaft vertical. Pull the paddle back in a straight line.



2. TRANSITION / As the paddle blade passes your body, twist your hands down and out; the thumb of the top hand points towards the water, and the blade rotates a quarter-turn. It now lies parallel to the direction of travel.



HEEL THE BOAT OVER by shifting your weight towards the paddling side. (This will shorten the boat's waterline and boost manoeuvrability.)

3. CORRECTION / Use your bottom hand to pry the blade away from the boat. Just a hint of ruddering will tame a bit of bow drift, but more correction will require a hard push. (You're doing it right if your tricep muscle protests.)



4. RETURN / Need a bit more correction? Drag the blade tip through the water (keep it shallow) as you bring the paddle forward.

Paddling on your own is like having a backstage pass to every overlooked dam and remote stretch of river. Take your canoe where you want, as fast as you want, without the hassle of co-

ordinating strokes – and schedules – with a partner. Burt Kornegay, owner of Slickrock Expeditions, has guided more than 400 trips, but he still likes going out on his own. "There's a sense of freedom,"

he says. "You can go at it hard or snooze all afternoon. And solo paddlers see so much more wildlife because they're quieter." Here's how to transition from two motors to one.

PM

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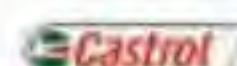
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SHELL ECO-MARATHON

In pursuit of energy-efficient motoring

In this image, teams line up on the track for a group photo on day one of the Shell Eco-marathon Challenge Asia, taking place at the Sepang International Circuit in Kuala Lumpur, Malaysia. The unique competition, staged in different locations around the world, challenges hundreds of student teams to design, build and drive the most energy-efficient car and travel the furthest on the least amount of energy. Some achieve distances equivalent to driving from Paris to Moscow (that's 2 485 km) on a single litre of fuel.

Running on a variety of energy sources (from conventional petrol and diesel to biofuels, natural gas, hydrogen, solar and electricity), they compete in two classes: the Prototype class focuses on maximum efficiency, with passenger comfort taking a back seat, while the UrbanConcept class encourages more practical designs.

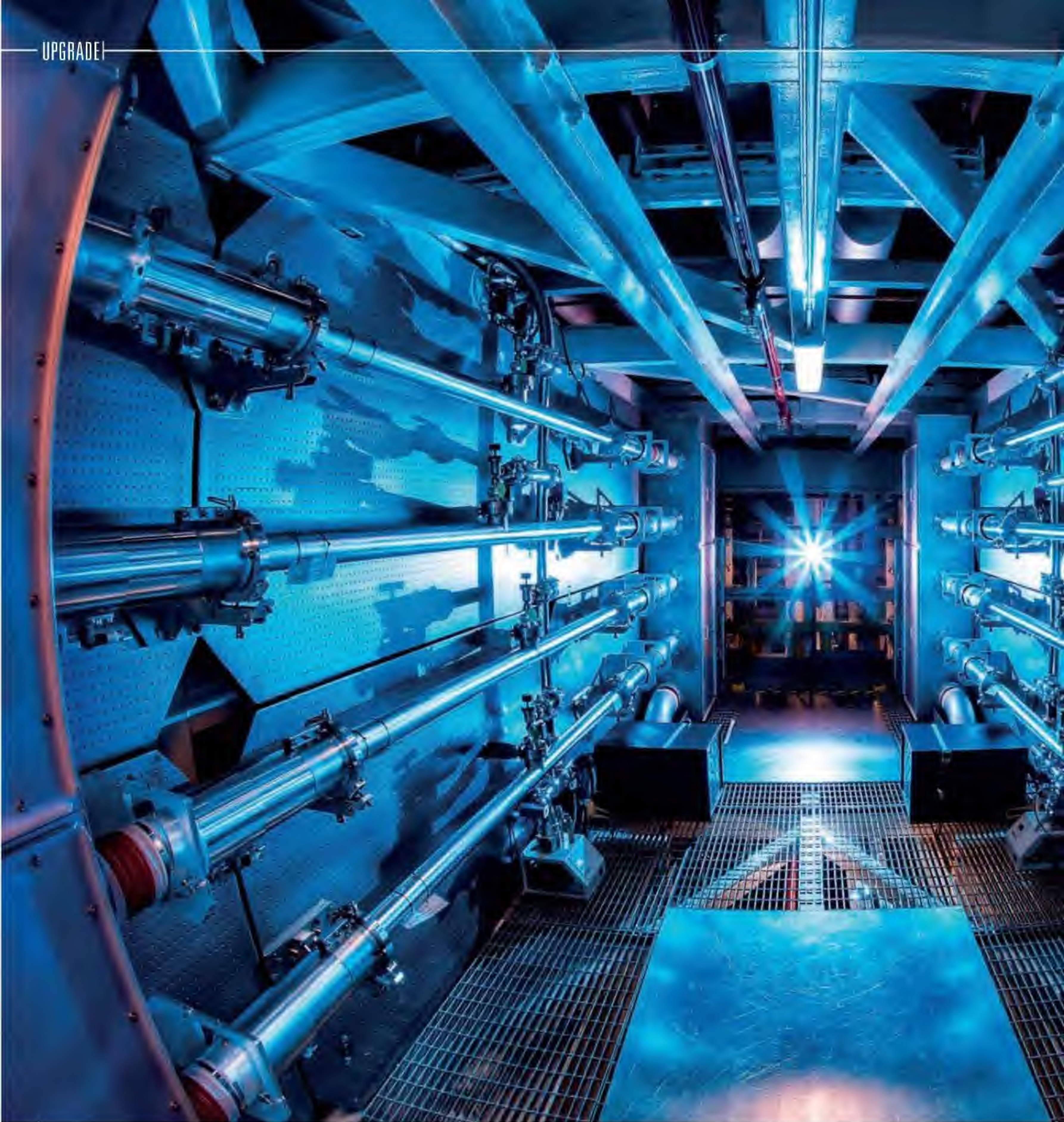


ECO-PERCH

Curved, organic, green... and you can live in it

If you're harmlessly obsessed with the indoor-outdoor flow, enjoy bold architectural statements and absolutely *adore* anything to do with the word "organic", you'll probably love the eco-Perch, based on UK firm Blue Forest's famous tree houses. Okay, let's get it over with: "Its natural, organic geometry maximises the relationship between the inside space and the outdoor setting, ensuring that the structure sits harmoniously within the landscape."

The eco-Perch sleeps four people and is delivered, assembled and commissioned in about five days (subject to site preparation). Being flexible, the design can be adapted to suit a site where existing infrastructure is already in place, and may be built on the ground or even among the tree-tops. To simplify the planning requirements, says Blue Forest, the building has been designed to conform to the UK's Caravan and Mobile Homes Act.



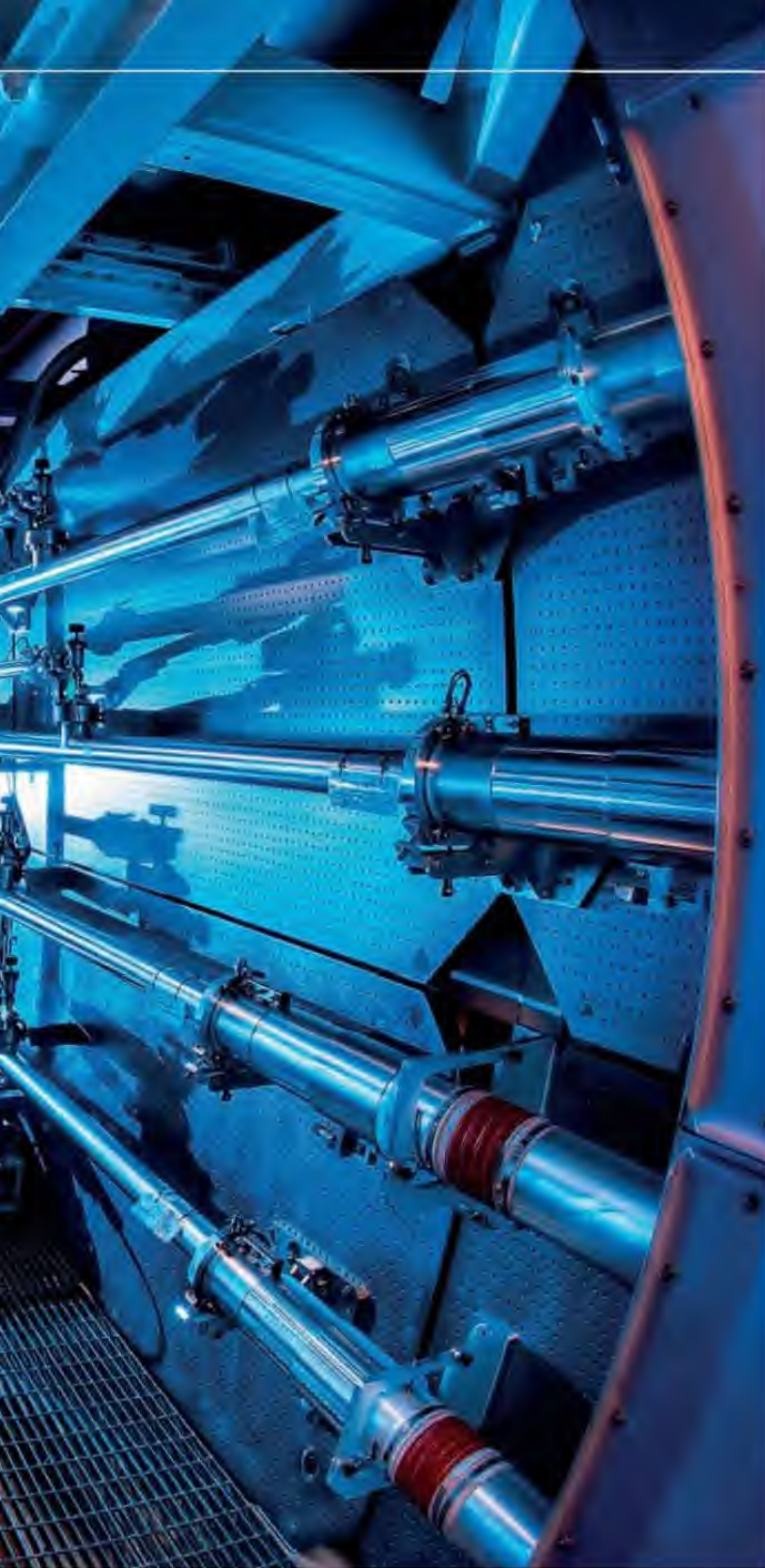
SERIOUS LASER

Would you believe 500 trillion watts?

Fifteen years of work by the Lawrence Livermore National Laboratory's National Ignition Facility (NIF) team has paid off with a record-breaking laser shot in which the system of 192 beams delivered more than 500 trillion watts (500 terawatts) of peak power and 1,85 megajoules of ultraviolet laser light to its

target. To put these numbers into perspective, you should know that 599 terawatts equates to 1 000 times more power than the United States uses at any given time, and 1,85 megajoules is about 100 times the output of any other laser in existence. Combining extreme levels of energy and peak power on a target

Damien Jemison/LLNL



> Visit www.popularmechanics.co.za to read more about the NIF's record-breaking 500 terawatt shot (search keyword: NIF laser).

in the NIF is a critical requirement for achieving one of physics' grand challenges: igniting hydrogen fusion fuel in the laboratory and producing more energy than that supplied to the target. In the historic test, the 192 lasers fired within a few trillionths of a second of each other on to a 2 mm-diameter target.



URBAN TURBINE

Is this the new face of wind energy?

A prototype for a new design of vertical-axis wind turbine that will generate electricity in urban areas, potentially revolutionising the renewables industry, has been installed at Keele University in the UK. Its designers say the turbine's scalable design – the work of a firm called McCamley – could one day incorporate office or residential space, transforming the future of the city landscape.

The turbine is designed to overcome many of the issues associated with the large horizontal-axis turbines commonly seen in wind farms. These turbines rely on a steady wind speed, whereas McCamley's vertical-axis model is able to cope with the turbulent and variable nature of the gusting wind conditions often found in urban environments. It continues to operate when the wind speed drops below 2 to 3 m/second, at which point conventional turbine models stop (and need to draw power from the grid to re-start when the wind picks up). The McCamley turbine is self-starting.

It can be assembled from "flat-pack" storable parts and retrofitted to a roof without a supporting mast, making it a viable source of renewable energy in cities and towns – areas previously seen as unsuitable for wind energy. Says McCamley CEO Scott Elliott: "We believe this design has the potential to be the new face of wind energy – and it's completely scalable, from 12 kW to larger megawatt designs."

PM

Long live Saab!

The original brand may be gone, but I'll always admire its innovative approach. > BY JAY LENO > PICTURES BY JOHN LAMM

Somewhere over in Sweden there's a Dumpster full of Saab letterheads, employee ID badges and day planners. There are guys going through what once were Saab's offices, hanging auction tags on the furniture, computers, printers and water coolers.

Saab went bankrupt in December 2011; in June, a company called National Electric Vehicle Sweden AN (NEVS) announced it would buy the marque, reportedly to make electric vehicles bearing the venerable name. NEVS is owned 51/49 by Chinese and Japanese interests, respectively, and China is the initial target market for the next generation of Saabs. But the Saab I knew and loved is gone, and I miss it.

When I was a kid, Saabs were unique. I first rode in one while I was in high school. A friend's mother had an old model with a two-stroke engine and a differential incorporating a freewheel hub system like the one on a 10-speed bicycle. It didn't go fast, but when my friend's mom took her foot off the accelerator pedal, there was no compression braking. The car just kept rolling along. I was fascinated.

Saabs were front-drivers when every American car had rear drive. Their two-stroke, three-cylinder engines sounded like popcorn machines – pppoppoppaaaawwwp – while other cars were muffled into silence. The first Saab car, the 1950 model 92, was built around an aerodynamically slick unibody. It rode on an all-independent torsion bar suspension and used something called rack-and-pinion steering. It was impossible to over-rev a Saab's engine because it ran out of power before the redline. So you just threw your boot at the accelerator pedal and shifted up until there was evidence of forward momentum. All that unconventional engineering led to good fuel economy: Saabs got better than 9,5 litres/100 km.

In the '50s and '60s, owning a Saab meant more than having an odd car in your

garage; it was a lifestyle choice. With that two-stroke engine, you had to premix your petrol and oil. So you trudged to the filling station with two 20-litre cans, filled them up most of the way with petrol, and then topped them off with oil at a 50:1 ratio. After a shaking to mix them up – and remember, petrol weighs roughly a kilogram per litre – you could fill the Saab's fuel tank. But there was never any oil sump to drain and virtually no other routine engine maintenance. Under the bonnet a clamp held an extra litre of premix oil.

On cold mornings, if you wanted to warm up a Saab's engine more quickly, you pulled a chain dangling from the dashboard to lower a "shade" that blocked airflow to the radiator. Naturally, the cabin heater was phenomenal.

My Saab is a 1958 model 93B. It doesn't have the key on the floor like later Saabs, but this was the first year for the one-piece front windscreen, and the doors are hinged at the back, suicide style. With a 750 cm³ engine making about 25 kW, it's not fast. But you can go 120 km/h down the road with four people in it. It has cruise control too; just put your foot to the floor and keep it there.

To me, however, my Saab's most fascinating detail is the water pump that's located on the back end of the generator. The Swedes could make it work, but imagine if a British car company had tried this. At best it would have functioned correctly; at worst it would have electrocuted anyone who touched it.

The winged logo on Jay's 1958 93B references Saab's aviation origins.





Beyond their engineering idiosyncrasies, though, Saabs were effective. The company was building rigid, lightweight and aerodynamic cars when other manufacturers ignored these considerations in their engineering. A Saab didn't look or drive like anything else on the road, and it attracted buyers to match.

It seemed for a while that every time a professor at a university in New England was awarded tenure, he or she got a Saab to go along with it. Intellectuals, eccentrics and other free-minded, countercultural types seemed to adopt Saabs almost instinctively. The author Kurt Vonnegut even owned a Saab dealership – Saab Cape Cod – in the late '50s.

When Saab switched to Ford-sourced four-stroke V4 engines in 1967, the brand lost some of its charm for me. Of course, Saab did some innovative things after that. The 1978 Saab 99 Turbo ushered in a new era of efficiency, and the later 900 Turbo was sophisticated. Then GM bought Saab, intending to turn it into a BMW competitor. Suddenly there were Saabs that were Subarus with new badges or Chevy TrailBlazers with their ignition key on the floor. Without quirkiness, Saab became just another car.

PM



Above: A handy bracket holds a spare can of two-stroke oil. Right: Saab was an early pioneer of aerodynamic bodies.



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> COMPILED BY ANTHONY DOMAN > anthony@ramsaymedia.co.za

CITROËN C4 AIRCROSS OFF THE BEATEN TRACK

The directions from Mozambique's N2 highway to Massinga Beach on the coast indicate "4x4 only". Now, even though Citroën's first SUV in the South African market does have 4wd on demand, you'd be forgiven a certain wariness. In these parts, conditions tend to tax, if not exceed, the abilities of the average Sandton kerb-jumper.

We needn't have worried. For one thing, the Aircross comfortably coped with the dozen kilometres of sand track through the bush. Its 200 mm of ground clearance proved to be ample. Where we hit particularly deep sand and uphill, momentum did the trick. Even the two-wheel drive versions were fine, though deflating their tyres to allow better flotation may have been partly responsible for a

few flats resulting from hitting hidden tree roots.

Citroën's launch of the Aircross shows its eagerness to get a slice of the SUV market, the second-fastest-growing area of new-car sales locally. Offered in two drive-trains (one with drive switchable between 2wd and awd, and other with just 2wd) the Aircross uses a 2.0-litre petrol engine developing 113 kW and 197 N.m. Transmission is either manual or CVT.

In positioning the Aircross, Citroën has consciously gone where the bulk of potential buyers are. It's only the most expensive model, the R369 900 Seduction CVT, that gets all-wheel drive. The rest, starting at R100 000 less, are geared to the urban SUV market



where the look is more important than the awd ability, though as we found the Aircross is still quite capable in conditions that would thwart normal cars but are doable for a soft-roader. The

mid-level versions offer a formidable range of standard features that add up to a highly competitive package. The list includes 7 airbags, funky detailing, and Bluetooth wireless streaming.





HYUNDAI i30 CLASS ACT

If any lingering doubts remain about Hyundai's ability to mix it with the big guns, this car should dispel them.

For a start, it looks the part. Design is a personal thing, but with a German-led team Hyundai has shown its awareness of where it perceives the i30 battleground to be: Europe. It helps that Thomas Bürkle, the man driving the company's design renaissance, has a pedigree in the Euro world. By Hyundai standards, it's been a stellar performer in Europe.

And then there are those matters of quality, refinement and performance, critical in a car that hopes to compete as a luxury compact. Naturally, all this comes at a cost, as bargain price and feature list become less important than what the buyer perceives as a higher-quality product.

Well, the i30's finishes and overall feel are really good. Its ride quality and

refinement are excellent at any speed. Engine response is steady rather than invigorating, but on the sweeping black-top of the Cape's Overberg region the i30 felt at ease whether ambling along, winding up for an overtaking burst or simply stepping on it.

Perhaps my only quibble with the i30 could be about one of its more notable features, the tri-mode electric-assist Flexsteer steering. Although precise and accurate enough, it just doesn't have the sensory feedback of its rivals. Some might say that's enough of a trade-off for the ability to adjust steering assistance; nice and light for parking, medium for everyday driving and sporty and stiff when you feel like pushing on and prefer control instead of comfort.

At launch, the i30 is available with a 95 kW 1,6-litre or a 110 kW 1,8-litre petrol engine. Either can be matched

with a 6-speed manual transmission; a 6-speed auto is an option on the 1,6. Economy is 6,4 litres/100 km for the 1,6 and 6,5 litres/100 km for the 1,8.

Even though Hyundai may be edging away from a long laundry list of features to woo buyers, the i30 doesn't sell them short. Its convenience and comfort features include a TFT information display, dual-zone climate control, and satellite controls on the steering wheel. Boot space is a roomy 376 dm³.

A host of safety features helped the i30 reach a maximum 5-star score Euro NCAP crash test score. Stability control, ABS brakes and 6 airbags are just part of the overall complement.

Price: from R229 900, including 5-year/150 000 km warranty and roadside assistance, and 5-year/90 000 km service plan.

NISSAN JUKE-R WANTED

The Juke-R began as half mad science experiment, half promotion. Nissan originally produced only two of these monsters, and it did so by chopping up a pair of 2010 GT-R supercoupés and appropriating their V6 twin-turbo motors and all-wheel-drive powertrains. The team fabricated a new floor and firewall and new mounting points for the GT-R's control-arm suspension and steering rig. Then they cloaked it all in an even funkier matte-black version of the Juke's sheet metal. Room inside is limited, thanks to a full roll cage and other modifications, but who cares? This is a mini-crossover supercar; three words that don't make sense together yet still promise fun.

The version we drove topped out at 260 km/h, but the R slips through corners like a lathery bar of soap. Now, thanks to a few interested buyers, there will be a limited run of build-to-order models based on the 2012 GT-R's guts. Sure, the estimated price tag is laughable, but the Juke-R's sheer audacity demands respect. – *Andrew Del-Colle*



THE STATS

Price → R5 million

Powertrain → 400 kW, 630 N.m; 3,8-litre twin-turbo V-6; six-speed, dual-clutch automated manual, AWD

Suspension → Control-arm with coil springs

Brakes → 390 mm front and 380 mm rear discs

Acceleration → 0–100 km/h: 3,3 sec

MAKING NOISE

TO MAKE ENGINES SOUND BETTER, SOME MANUFACTURERS BROADCAST ENGINE NOISE THROUGH SPEAKERS. HAS A LINE BEEN CROSSED? *By Larry Webster*

Anyone who's heard a Ferrari V8 at full wail knows perfectly well that engines make music. But today, that vroom-vroom is getting harder to hear, thanks in equal parts to turbochargers that muffle the noise, increasingly insulated cabins, and government noise regulations.

Car manufacturers are well aware that a snarly engine note enhances the behind-the-wheel experience. The Chev Corvette's exhaust system has a valve that opens under full throttle and bypasses the silencer. The Porsche Cayman and the Ford Mustang both have "noise pipes" that connect the intake system to the cabin. These passive systems, however, are slowly being replaced with

active systems that play a prerecorded track through speakers.

Case in point: VW's GTI used to have a noise pipe, but when the latest version appeared in 2011, the pipe was replaced with the Soundaktor. This system uses a hockey-puck-size speaker mounted on the firewall to generate extra noise. VW didn't exactly advertise the feature, and when word got out, the forums lit up.

"The Soundaktor is only there to lie to me," fumed one GTI owner on [vortex.com](http://www.vortex.com) when he found out his car had the system. "It's false advertising, plain and simple."

VW is not alone. The new BMW M5, which ditched the sonorous V10 for a



Sam Kaplan

twin-turbo V8, plays an engine soundtrack through the car's audio system. From a carmaker's perspective, these active sound generators have definite benefits over a sound pipe: there's no need to cut a hole in the firewall or package a separate tube in the already crowded engine bay. Plus, the active devices allow a far greater degree of tunability and can be used to mask unwanted noise.

VW AMAROK

BEEFED UP

The Amarok has taken a significant slice of the local market in its short two-year existence. And that slice could get bigger: word is that an SUV version is on the horizon, aimed at competing with the likes of the Toyota Fortuner and Mitsubishi Pajero Sport.

No small part of the Amarok's success can be attributed to its modestly sized (and therefore thrifty and emission-friendly) but nevertheless powerful 2-litre engine and its overall modern carlike feel and high-level safety features. There's a distinct appeal to a more urban, contemporary buyer

rather than the traditional bakkie owner. Paradoxically, it's that 2-litre engine that has prompted – not unrealistically – some mutterings. For 2012, the topline Amarok now features a biturbo diesel with a healthy 132 kW output. There is also a 90 kW version and a 118 kW petrol.

Our test drive of the uprated model took in a mix of surfaces from rolling freeway to dirt. A particularly badly corrugated section of gravel road felt unsettling at times, with the rear of the 4x2 double cab occasionally drifting off line. I suspect a load would have helped stabilise things, and possibly 4wd. The ride comfort, though, was very good.

It's hard to judge on that evidence whether the extra power makes a significant difference in heavy going, but there's no question that the combination of plentiful urge and slick 6-speed transmission provide ample overtaking ability.

All Amarok double cabs are fitted with a switch-operated electronic differential lock. In really tough conditions, another switch activates Off-Road mode; up to 100 km/h, this tunes stability control and braking systems for the conditions. Its features include a unique-in-class Hill Descent Assist that can be adapted by the driver.

Economy is a strong selling

point. The official figure is 7,9 litres/100 km for the 4x2, and we managed between 8 and 8,5 without making any efforts at economy.

One area that troubled early Amaroks does seem to have been noticeably improved. VW concedes that there had been complaints about the difficulty of synchronising clutch and accelerator, resulting in jerky pullaway and shifts. The 2012 Amarok, we can report, has cleaned up its act; gearshifts are now more in line with what you'd expect.

Price: from R313 500, including 5-year/90 000 km service plan.





NISSAN INFINITI SECOND BITE AT THE CHERRY

By the 1980s, Japanese manufacturers trying to make a go of premium cars found that all the build quality, performance and features in the world weren't enough to shake off their mass-market image. Nothing could compete, it seemed, with the snob value of a pedigreed badge. So they created their own stand-alone brands.

As a strategy, it's had mixed results. Despite this, the likes of Infiniti have managed to carve out a niche for themselves. Briefly seen here in the 1990s – and then only with a single model, the big Q45 luxury sedan – Infiniti never really had a chance to set the local market alight. Fast forward to the present, and with the company's moderate international growth accelerating and a decision to locate its global HQ in Hong Kong, it looked like a good time to retry South Africa.

The local range consists of the:

- M luxury sedan (M30d);
- FX performance SUV (FX30d, FX37 and FX50);
- EX compact SUV (EX30d and EX37);
- G Coupé (G37); and
- G Cabrio (G37).

V6 and V8 petrol engines, V6 diesel engines and a 7-speed automatic transmission are available across the range. Other engine options, including hybrid, are under consideration.

All of that's backed up by a brand-new team of dedicated Infiniti personnel, with in-house finance and five model lines being sold out of two dealers in Gauteng initially and 10 by 2014.

Our first taste of the new Infiniti range came in the shape of the FX luxury SUV. Its curvy styling looks imposing from the

outside and just a little old-school (pleasingly so) from the command post. The FX is no rumbling continent-crosser: if anything, it feels like a big muscle car. And, by the way, it goes like a big muscle car. The ride is firm and the engine feels urgent. The interior, though, feels like a traditional luxury sedan's, complete with distinctive dashboard-mounted clock.

The range-topping FX50 is powered by a 5-litre V8 that produces a breathtaking 287 kW and 500 N.m. Acceleration of 5,8 seconds to 100 km/h and a top speed limited to 250 km/h are more usual in a sports car, though the average fuel consumption of 13,1 litres/100 km isn't. There are also a 3,7-litre V6 petrol engine that isn't much slower, or much less powerful (235 kW and 360 N.m) and a turbocharged diesel V6 that consumes 9,0 litres/100 km.

Less utility, more sport. All-wheel drive is standard across the FX range in the form of Infiniti's ATTESA E-TS (Advanced Total Traction Engineering System for All Electronic Torque Split), which surely takes longer to say than to act. Usually rear-drive, the FX uses a central clutch to channel drive to the front as needed. At its limit, the torque is split equally front-rear.

Even the chassis is designed to be sporty, with a front-midship engine position and rear-drive bias for better weight distribution and centre of gravity. Upscale models get variable-mode continuously adaptive damping. In addition to this, Rear Active Steering uses electric motors to steer the rear wheels (up to 1 degree). Swivelling the rear wheels opposite to the direction of the steering at low speed sharpens turns; swivelling them in the same direction as the front wheels aids high-speed stability.

TOYOTA YARIS HSD

HONEY, I SHRUNK THE HYBRID

The marketplace success of the budget-friendly Etios may have taken some of the shine off Toyota's Yaris subcompact – perceptions of problematic pricing aside – but there's no question that the hybrid version will help shake things up. The Yaris HSD (for hybrid synergy drive) is the world's smallest and, at 88 g/km, SA's lowest carbon emitter.

We were familiar with hybrids' economy, but we weren't prepared for just how economical the Yaris version is. Its quoted consumption is 3,8 litres/100 km; on our 120 km test route, under some pretty intense scrutineering, the HSD averaged under 3 litres/100 km. That's astonishing.

On another note, Toyota reckons it has minimised the annoying wind-up high-revving effect of a typical CVT. The car's new control system, optimised at between 70 and 90 per cent of throttle opening, limits excessive revs under acceleration. Look, it's not perfect, but we'll concede that this CVT now sounds less like a Piper Cub on take-off.

At R233 800, the Yaris HSD is up against some formidable rivals. Turbodiesel alternatives offer an arguably competitive and more practical (in South Africa, anyway) option. Still, the Yaris's novelty value, its green cred, long features list and its amazing economy could prove persuasive.

Sustainability by the numbers

- 1 000** Yarises produced daily at Toyota Motor Manufacturing France (TMMF)
- 25** percentage of hybrids TMMF expects to produce in 2012.
- 100** percentage of waste recycled or recovered at TMMF
- 60** Percentage of the plant's total water



needs covered by either rainwater or recycled water

27 Percentage savings per car in energy over the past 10 years

400 000 reusable plastic boxes (scheduled lifespan 10 years) used for delivering all car components from suppliers.

Aero advantage

A body shape like the Yaris's, short and squat, isn't ideal for efficient aerodynamics. Getting the most out of the HSD is an operation that stretches from nose to taillights. Up front, aero corners, bonnet,

bumper and grille smooth the airflow over and under the car as well as into the engine compartment. The A pillar, door mirrors, roofline, rear spoiler, rear bumper corners, rear combination lights and wheels are all optimised for aero efficiency on the sides and top. A front spoiler, engine undercover, and front, centre and rear deflectors smooth out flow under the car. A rear undercover incorporates vertical fins, creating a laminar flow effect (airflow in smooth, unscrambled layers). The result: what Toyota says is a class-leading drag coefficient of 0,286.



DUCATI 1199 PANIGALE RUMBLE IN THE URBAN JUNGLE

There are six ECUs to regulate the complex array of electronics found in the Ducati 1199 Panigale, but this superbike's strong suit isn't its traction control, engine braking or available suspension adjustability. What gives this feisty Italian an edge over its worthy Japanese and German competitors is the signature rumble from its 1 199 cm³ engine and that singular feeling of personality so intrinsic to the formula of a desmodromically valved big twin engine. Our day of riding the Panigale at the Formula One Circuit in Abu Dhabi saw high cornering speeds and an ultimate velocity of 270 km/h.

Yet for all the 1199's ferocity, it's still user-friendly – proof that Italian character doesn't have to be devoid of confidence-inspiring security. – BASEM WASEF



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Infotainment is fast catching up with our connected world. Latest from Mercedes-Benz is news about politics, business, science and technology, health, sport and entertainment via the company's News app for its COMAND Online multimedia system.

The news, including photos, can also be shown on the vehicle's display screen. The latest news and images from all over the world are provided on an exclusive basis by the German news agency group dapd, which co-operates with news agencies in 22 countries around the world, and supplies its special in-car News

package in 28 different languages. Each time the dapd news ticker is updated, the latest information is available in the car too, in the appropriate language. Mercedes-Benz customers are also able to select country-specific settings; for example, the country from which they would like to receive the top news feed.

Available as a standard feature on the Mercedes-Benz SL, the News app will be available from mid-July for all new Mercedes-Benz models fitted with COMAND Online. Installation is via a download from the Cloud.

MERCEDES-BENZ ML NOW COMES IN GREEN

Not quite under the radar, but perhaps less overt than its SUV counterpart from Munich, and less utilitarian than pukka 4x4s like its GL stablemate, the ML quietly goes about its business of providing the peerless M-B experience in a sport-utility package. Which is to say, you get the ride, the power, the refinement, the luxury and, of course, the badge. These days, according to Mercedes-Benz, you get fewer visits to the pumps, too. After all, being able to afford a big, bluff vehicle weighing a couple of tons, with a mighty engine just a toe-twitch away, doesn't exclude you from being cost-conscious. It's all relative.

Now in its third generation, Merc's awd mainstay exudes the marque's trademark

feeling of solidity and assurance. With that, it has gained a reworked chassis (incorporating selective damping) and clever drive-assist systems aimed at as involving a driving experience as possible, given that it's an SUV.

But above all M-B is emphasising this new generation's energy efficiency. In brief, the 2013 ML uses up to 28 per cent less fuel than its predecessor. A new model, the 250 BlueTEC 4MATIC, is said to use 6,5 litres/100 km, giving it a potential range of up to 1 500 kilometres on a full tank. It's notable that you can now get a diesel ML solely in eco-friendly BlueTEC form with SCR emissions technology. In addition to that, says Merc, the focus is firmly on downsizing. That doesn't necessarily apply at the top end, where it's stomach-churning power and torque as usual in the ML 63 AMG, with its V8 engine producing 386 kW and 700 N.m.

However, the 250 uses a 150 kW/500 N.m four-cylinder, 7-speed automatic transmission with "fuel-economy" torque converter, friction-optimised bearings, a transmission oil thermal management system, low-friction axle drives, electric steering, optimised belt drive with de-coupler and the on-demand control of all ancillary components and pumps in addition to intelligent lightweight design. Its drag

coefficient of 0,32 is described as setting a new best figure for this vehicle class.

Tuned driving dynamics. The optional ON&OFFROAD package features six driving modes for optimising driving dynamics and handling safety: automatic, two off-road modes and three on-road modes. The physical parts of the package are an underguard, a two-stage transfer case with reduction gear and an inter-axle differential lock. Upgraded air suspension boosts ground clearance to 285 mm and fording depth to 600 mm.

Price: from R683 500 for the 250 model to R1 380 000 for the ML 63 AMG; a 6-year/120 000 km maintenance plan is standard.



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In terms of its implications, the road train that traversed 200 km of motorway in one day outside Barcelona in Spain recently represented a breakthrough in the concept of platooning. It was the first test drive of a road train consisting of both trucks and cars among other road users. At 85 km/h, three Volvo cars and another Volvo truck followed a lead Volvo truck with just 6 metres separating each.

It was all part of the EU-funded SARTRE (Safe Road Trains for the Environment). Following vehicles used existing vehicle safety systems – for instance, cameras and radar – to monitor the lead truck as well as other vehicles in their immediate vicinity. By adding wireless communication, the vehicles in the platoon “mimic” the lead truck. This allows accelerating, braking and turning in exactly the same way as the leader.

The SARTRE project, under way since

2009, is a joint venture between seven European partners, including Volvo Trucks. It has covered about 10 000 kilometres in total.

“(In the latest test) the truck behaved exactly as expected, and the following vehicles responded just as planned. It was great to be a part of this landmark event,” says Andreas Ekfjorden, Project Manager for Volvo Trucks in the SARTRE project and test driver of the lead truck in Spain.

The driver of the lead truck has a key role in the SARTRE project. The project mission states that the driver of the lead truck must be a professional and must be specifically trained for the task. For the drivers of the following vehicles, the aim is to allow them to relax since they will be continuously supported and can even let go of the steering wheel. For the professional driver of the lead truck, however, being at the helm of a vehicle



platoon is a great responsibility, so he/she is supported by a number of safety systems such as Volvo Trucks' Lane Keeping Support, Driver Alert Support and Alcolock.

The SARTRE project also has environmental goals. Running close to each other limits air drag and improves efficiency. It also optimises traffic flow, so allowing more efficient use of road capacity. This could add up to huge benefits for the haulage industry, in particular, but there are implications for all road-users. PM

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Breathtaking advances in computing power, the explosive spread of wireless connectivity, the ever-evolving Internet, breakthroughs in consumer tech, the social media landscape, humanity's relationship with technology, our automotive future... all this, and more, will be tackled by presenters at the top of their game.

The inaugural **FutureTech** conference happens on 25 October 2012 in Johannesburg; bookings are open now. To reserve and pay for your seat, please visit www.magsathome.co.za. For more information, e-mail Nomfundo Calana on nomfundoc@ramsaymedia.co.za with "**FutureTech updates**" in the subject line, or call her on 021-530 3204.

In the meantime, here's a taste of what's to come (more programme details will follow in the coming weeks):

PITCH IT TO THE PANEL.

Reprising a popular segment from last year's event, we'll be inviting finalists from our annual PM Inventors Competition to present their inventions to our panel of experts (and to you, the audience) for comment and advice. You'll be impressed and inspired by their home-grown ingenuity.



ANNAMART NIEMAN was formerly a partner at Deloitte & Touche, where she headed a multi-disciplinary team that included cyberforensic experts, forensic auditors, computer engineers, forensic investigators, information security specialists and data analysts. Now a practising advocate, Dr Nieman has frequently presented at national and international conferences, and has also been a guest lecturer at the FBI Academy in Washington. As prosecutor, senior state advocate and legal advisor, she was involved in high-level management of all National Prosecuting Authority investigations, focusing on racketeering, money laundering and asset forfeiture.
HER SUBJECT: "Policing Cyberspace: Should We Be Afraid?"

GEORGE ELLIS, Emeritus Distinguished Professor of Complex Systems in the Department of Mathematics and Applied Mathematics at the University of Cape Town. Professor Ellis co-authored *The Large Scale Structure of Space-Time* with University of Cambridge physicist Stephen Hawking (in 1973), and is considered one of the world's leading theorists in cosmology.
HIS SUBJECT: "Science, Technology and Humanity."



TIM NOAKES, Professor in the Discovery Health Chair of Exercise and Sports Science at the University of Cape Town. He is also director of the UCT/MRC Research Unit for Exercise Science and Sports Medicine, and co-founder (with rugby legend Morné du Plessis) of the Sports Science Institute of South Africa.
HIS SUBJECT: "Your Body, Your Future: Getting the Science Wrong."

ALAN KNOTT-CRAIG is founder of *World of Avatar* and CEO of Mxit, Africa's largest social network. Between 2003 and 2006, he co-founded five companies in the mobile services sector. He's a former MD of broadband network operator iBurst and author of the best-seller *Don't Panic*, a book aimed at persuading emigrant South Africans to return home.
HIS SUBJECT: "In Pursuit of a Better-Connected Planet."



JAMES MUNN is vice-president of business development in sub-Saharan Africa for wireless giant Qualcomm. Based in Johannesburg, he manages Qualcomm's strategic relationships with OEMs and the company's regional customers, including network operators and carriers, mobile handset vendors and software developers.
HIS SUBJECT: "How Wireless Rules the World."

JUST THE FACTS

- The one-day FutureTech conference takes place on 25 October 2012 in Johannesburg.

- Only 200 seats are available at an "early bird" cost of R1 595 each (offer closes on 25 September 2012). Thereafter, the fee increases to R1 895.

- All bookings close on 12 October 2012. Updates will be announced via our Web site, our weekly Web letter, our Facebook page and other media channels.

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TOMORROW'S TECHNOLOGY TODAY ● Popular Mechanics Be the first to know

Popular Mechanics

Rev it UP

BY SEAN WOODS

MINIMALISTIC FLYERS GET THEIR RUSH FROM THIN AIR

Soaring freely through the air, with a pristine landscape below and nothing but blue sky over your head, produces a sensation that's hard to beat – and if sensation is what you're after, paramotoring is undoubtedly the way to go. We take a flip and get the lowdown on this exhilarating sport.

LONG BEFORE Frenchmen Jean François Pilâtre de Rozier and the Marquis d'Arlandes clambered aboard their hot-air balloon in 1783 to become the first bona fide aeronauts, mankind has gazed heavenwards and fantasised about soaring with the eagles. Their pioneering spirit lives on among a band of intrepid flyers who shun cosy cockpits and enclosed fuselages, much preferring the sensation of rushing air on their bodies while traversing the skies.

To get their fix, these adventurers strap motors to their backs, unfurl their non-porous nylon wings and run into the wind, relying on thin nylon lines and an air-filled canopy above their heads to carry them aloft and keep them there. Welcome to the fun-filled sport called paramotoring.

As intrepid flyers go, Tony Gibson – an avid fixed-wing pilot since 1985 – is up there with the best of them. One of the founders of paramotoring (also called powered paragliding, or PPG) in South Africa, he switched from paragliders to paramotors 22 years ago, effectively teaching himself everything he needed to know. It's a young sport, coming into being only about 1990, when paragliders realised that by adding a backpack motor to their kit, they'd be able to take off from level ground rather than have to launch themselves off cliffs, hills and the like.

Now, with about 5 500 flying hours under his belt (that's just on paramotors), Gibson co-owns Flying Unlimited, the country's largest paramotor flying school. The man's credentials are formidable: he's won the South African PPG championships three times on the trot, he holds the standing world record for "speed over a closed circuit of 100 km without landing" (by a very big margin), and he captains the South African paramotor team.

I'm a shameless flying junkie, so when

Gibson's business partner and fellow PPG instructor, Riaan Struwig (who, incidentally, is also a member of the national PPG team), invites me for a flip, it's a no-brainer: I immediately book my ticket on one of those boringly conventional sardine-can flights to Gauteng and prepare myself for some *real* flying.

The moment I arrive at Grasslands Sports Facility near Centurion – an old instant-lawn farm comprising 150 hectares of obstruction-free soft turf and home base of Flying Unlimited – I can tell I'm in for a great day. Children, accompanied by a motley pack of good-natured mutts, are



'Although it's possible to fly in turbulent conditions, it can get rather uncomfortable. We prefer to fly early in the morning or late in the afternoon, when the air's more stable.'



Apart from being an absolute blast, paramotoring is by far the cheapest form of motorised flight – making it an excellent option for wannabe flyers on a budget. And, thanks to the fact that these minimalistic machines are always gliding (the motor's only used to get them airborne), it's also one of the safest forms of flying you can get.





Flying Unlimited's Riaan Struwig (left) and Tony Gibson.



SA paramotor team member Paul Jackson runs into the wind to take off.

'You need a minimum of 35 flights under your belt before being considered ready for your final flight test.'



Paramotor backpack kits can easily fit into an average hatchback without needing to be disassembled, making the sport extremely portable.

taking full advantage of the expansive area to let off steam, while the adults, clustered around various pieces of kit, are having just as much fun discussing the finer aspects of paramotoring (along with debates over the best time to light the braai fires).

Says Gibson: "This sport is very family oriented, so we've designed the club to include all our members. We even have a

safe, enclosed play area for the kids and pets to keep them occupied while we're flying."

Although it's already past midday, my hosts deem it too early to fly, so the fires are lit. Soon, boerewors rolls become the order of the day as everyone hangs around, waiting for the predictable Highveld thermals (which cause turbulence) to subside and the cooler, late-afternoon air to settle in. Says Gibson: "Although it's possible to fly in turbulent conditions, it can get rather uncomfortable. We prefer to fly early in the morning or late in the afternoon, when the air's more stable."

FREEDOM TO SOAR

The beauty of paramotoring lies in its accessibility. In fact, it's by far the cheapest form of motorised flight, making it an excellent option for wannabe flyers on a budget. To give you some idea of costs, if you can afford to spend about R100 000, you're ready to go. This buys you a new, if somewhat basic, backpack kit comprising motor, wing, helmet, radio and student pack as well as training fees and a radio course. Throw in an extra R20 000 and you can get your hands on a basic trike. If buying used, expect to spend anything from R60 000 to R80 000 for a decent second-hand backpack rig. Once your gear is in place, the only real expense is



Left: The non-porous nylon wing uses a number of air-filled intake cells to create lift. Middle: Backpacks incorporate engines from 125 to 230 cm³ in size and have a dry weight of around 32 kg. Right: Typical instrumentation includes a VHF radio, GPS plus vario and altimeter combo.

incurred by a modest fuel burn of about 4 litres per hour.

Gibson elaborates: "One thing about this sport... it's a leveller. It doesn't matter how much money you have or where you come from. Even if you're a veteran fixed-wing or helicopter pilot, if you don't practise much, there's always going to be someone who performs better than you. This reality fosters great camaraderie among flyers."

The gear is also surprisingly portable, something I couldn't help but notice when club members began assembling their kit for their afternoon flight. The backpack, including engine, has a dry weight of about 32 kg and can easily fit into an average hatchback without needing to be disassembled. The wing, once packed, has the dimensions of a medium-sized tent. "We take our aircraft on holiday with us!", quips Gibson.

Another reassuring aspect of this sport is its good safety record. "Remember," says Gibson, "we're always gliding. We just add a motor to get us into the air. If the engine fails, no problem – you can land easily, anywhere. Because landing distances are so short, typically only about four steps, you could land on a street corner if necessary."

In the unlikely event that the wing collapses or suffers cataclysmic failure – something that has never happened to Gibson in all his years of flying – there's always the hand-deployed emergency parachute to get you out of trouble. "Although having a reserve 'chute isn't required, almost everyone flies with one. I carry mine all the time but I've never had to deploy it."

UP, UP AND AWAY

At long last, it was my turn to get airborne, and Gibson strapped me into the tandem seat XCitor trike. Manufactured in Germany by Fresh Breeze, this beautifully engineered machine (it costs R380 000 – an absolute fortune in paramotoring terms) is without a doubt the Rolls-Royce of power paraglider trikes. Features include a streamlined alu-

minium aerocage, a wide wheelbase (for more forgiving take-offs and landings) and a low centre of gravity. The economical 52 kW engine is equipped with a digital motor management and digital injection system, and it comes with full instrumentation. Cruising speed is about 60 km/h.

Another cool feature is the integrated trailer coupling, which allows you to transport the trike to your chosen launch site without a special trailer. Perhaps most reassuringly, it also comes equipped with a ballistic rocket recovery system that guarantees safe landings from altitudes as low as 30 metres.

Gibson cranks the throttle and in no time, we're airborne. Now, I've done a lot of flying in small aircraft in my time, so I imagine I know what to expect. I'm wrong; the sensation is much gentler than anything I've ever experienced before.

The afternoon air is still a bit bumpy, but that doesn't detract from the experience at all. The flexible, air-filled wing, along with its accompanying mass of nylon lines, seems to absorb the harshness of the turbulence, making it feel, well, as if we're floating.

Gibson throws us into fast and high bank-angle turns close to the ground, puts us into head-spinning spirals at altitude and performs a series of touch-and-goes. We also spend a fair amount of time formation-flying with another XCitor trike and a few "foot-launchers", giving me an opportunity to shoot some aerial photos, not to mention savour the oncoming sunset and the hazy Highveld landscape far below. Throughout the entire hour-long flight, I find myself distracted by a struggle to come up with appropriate adjectives, finally settling for something on the lines of "it was an absolute blast!".

After landing, I mention my dilemma to Gibson, who laughs. "Even with all my years of experience, I still struggle to describe the feeling. The best explanation I've been able to come up with is that it's like running into the

air... you know, when you're dreaming. What I *do* know is that it's like a drug. If you miss a few weeks of flying, you end up making every excuse under the sun to get out and fly."

LEARNING THE ROPES

Fortunately, learning to fly isn't rocket science. Training is broken down into three modules: ground handling (where you learn to control the wing), engine training, and learning to fly – that is, from going solo up to the point where you're awarded your licence. According to Struwig, the most difficult part is learning to handle the wing. "Keeping it stable and above your head is the trickiest part. This can take anything from one to three weekends, depending on the individual. Only once you've got that right do we move on to the motor."

You need a minimum of 35 flights under your belt before being considered ready for your final flight test. This involves performing spot and emergency landings, spiral turns and crosswind take-offs. Struwig says most trainees are ready to tackle cross-country flights with experienced pilots by flight 15. "It all depends on how comfortable they feel, really."

As we went to press, Gibson and his teammates were training flat-out for the 2012 Paramotor World Championships taking place in Marugan, Spain. Considering that the South African team can muster only nine pilots (a full team comprises 18 members), their track record is pretty good: they came 9th overall in 2007 and 6th overall in 2009.

Says Gibson: "Although we hope to improve on our 2009 results, we can't expect to win because we don't have a full team. The reason is simple: we just don't have enough competitive pilots in this country. We need to draw more people into the sport."

If you'd like to know more about the thoroughly invigorating sport of paramotoring, contact Riaan Struwig on 082 653 7504. Alternatively, visit Flying Unlimited's site at www.ppg.co.za

PM

Invent something...

**AND
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istockphoto/Andrey Burmakin

ARE YOU AN INVENTOR? Would you like to walk off with R50 000 in cash and a prestigious title in recognition of your groundbreaking idea? Then get cracking on your entry for the 2012 **POPULAR MECHANICS** Inventor of the Year competition.

Our annual challenge to inventors throughout South Africa invites original ideas in two categories: **Emerging Genius** (for previously disadvantaged and minimally resourced entrants) and **Cutting Edge** (open to anyone). Each category winner will receive R20 000 in cash, and the overall winner will be awarded an additional R30 000 plus a floating trophy and the title of Inventor of the Year.

Rules? There are a few, but we've done our best to make it as easy as possible. For example, your invention must be your own, original work, and it must be fresh (in other words, don't submit something that was featured in your local newspaper 20 years ago). It should also serve a genuine purpose: whereas you might believe a combination nose-hair clipper and tea strainer is exactly what the world needs, you're probably wrong. And finally, keep it real: your rough sketch of a fusion-powered bicycle won't cut it.

WHAT'S YOUR NEXT MOVE?

Start working on your entry right now – but first, do your homework. Research it on the Web to make sure your invention isn't replicating someone else's idea (you'd

be surprised), gather all the relevant information on your target market, and if possible, build a working prototype (there's nothing quite as reassuring to a judging panel as an invention that clearly works). Provide the judges with as much information as possible, including photographs and drawings (if applicable), and be sure to spell out your perception of the target market. For entry forms and the "rules of engagement", please visit our Web site at www.popularmechanics.co.za or send your entry to invent2012@ramsaymedia.co.za

Note: Some finalists will be invited to showcase their concepts to delegates at PM's exciting FutureTech conference in Johannesburg on 25 October.

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20 Ways to take a better photo

BY WOOK KIM

Square-one advice: **[1]** Get to know your camera. Spending time with the user manual won't kill you. Some cameras even display tips on-screen while you're shooting, as pop-ups or in help menus. Use the advice; you'll be glad that you did.

[2] Keep it clean. Smudges, specks of dirt and other nasties ruin a shot. Stash your camera in a case; buff the lens with a microfibre cloth.

Balanced, centred, gaze-into-the-lens portraits are boring. **[3]** Have the subject look off-frame, and **[4]** use the rule of thirds: Imagine a noughts-and-crosses grid within your camera frame and set your subject at one of the intersections. In a head-and-shoulders shot, align the subject's eyes



with the top horizontal line of the (imaginary) grid.

[5] Get up-close and personal. Capture one part of the body – eye, mouth, bare shoulder – because details can be telling. You don't need a zoom for this. In fact, we recommend that you **[6]** use a prime lens, which has a fixed focal length. With this type of lens, you zoom with your feet (step back or forward) to compose your shot within the frame. A prime lens also often has a low F-stop rating, which lets you **[7]** achieve a shallow depth of field. Dial down the F-stop and pull your subject into focus, and the background will blur, creating visual separation. Also regarding back-

grounds: **[8]** avoid clutter. A neutral backdrop keeps the emphasis on the subject. **[9]** Place your subject in an unusual setting. Shots that take people out of their comfort zone yield unexpected reactions. But don't go nuts: asking your nephew to pose next to the lion is not okay.

On overcast days or in the shade, **[10]** use your flash as a fill light to illuminate faces. Also, **[11]** get a hot-shoe bounce flash if your camera supports it. A bounce flash lets you manipulate light by reflecting it off a ceiling or other bright surface. With a basic point-and-shoot camera, **[12]** use a sheet of white paper to direct or diffuse

light from a lamp or other source. Speaking of light, **[13]** avoid having your subject look into bright sunlight, unless you like squinty eyes and ugly shadows. If you must shoot in a sunny setting, **[14]** let the light fall at an angle across the person's face. But if you can wait, **[15]** shoot just after sunrise or before sunset, when the light is softer and the colours warmer.



When snapping pics of kids or pets, **[16]** take a knee. Their cute mugs look even better when captured at their own height. Of course, you may also **[17]** shoot high or low: odd angles add drama.

[18] Take your camera everywhere as the best photos aren't planned. And always **[19]** carry extra batteries and memory cards. Having a camera with you that can't do the job is worse than having no camera at all. Now that you're fully equipped, **[20]** shoot multiple shots at a time. The second or third shot – or the fifth one – when your subject begins to relax, can be the best one.

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DIGITAL CLINIC

> BY THE EDITORS

Purloined profile

Help! Someone has hijacked my Facebook account and is posting nasty things about me. How can I regain control and get rid of the embarrassing lies?

A Anyone with malicious intent and a little bit of tech savvy has a frightening number of options at his disposal if he is interested in taking over a Facebook account. In 2010, Seattle software engineer Eric Butler developed Firesheep, a Firefox extension that made it easy to hijack unencrypted browsing sessions on a public network. For a time Firesheep made logging in to a social network in a coffee shop or library an open invitation to your private account for anyone who was looking.

According to Tim Armstrong, a malware researcher at Kaspersky Lab, Facebook now has default encryption built into its site, which should fend off Firesheepers, but he believes that recent updates to Facebook have opened up other modes of attack. "Facebook changed the layout of the site recently so that it prompts you to reveal where you went to high school, your family members, the town you live in; all this information that is almost a one-to-one with password-reset questions," he says.

Armstrong thinks the oversharing that occurs in a typical Facebook profile makes it easy for others to research their way through the typical questions that are asked by either Facebook or on-line e-mail providers when you forget your password.

Then again, maybe you just forgot to log out when you used a public computer (another big vector for hijackers). Regardless, once somebody gets into your account, it's a simple matter to change the password and lock you out, then post practically anything under your name. And if that isn't bad enough, there is the potential for collateral damage through Facebook Connect, which uses your Facebook credentials to log in to other sites. So you're going to want to act quickly.

Facebook knows this is a danger and has tools for remediation. The company suggests that anyone who suspects his

account has been hacked go to facebook.com/hacked, where users can lock down their account, change the passwords of linked e-mail accounts, beef up account security, and generally repair any damage.

Frederic Wolens, a spokesman for Facebook, calls security an arms race. "Our teams are always working to

identify the next threat and build defences for it," he says. "Most of these defences are invisible to users, and although malicious actors are constantly attacking the site, what you see is actually a very small percentage of what's attempted." Facebook does, indeed, have a large team dedicated to improving the security of the site, but once you get that account back up and running, we'd still advise heeding Armstrong's warnings about oversharing.

SMARTPHONE WIPEOUT

Q I've recently upgraded my smartphone. I want to sell the old one online. Do I need to take precautions to ensure that its new owner won't be able to lift any residual personal data?

A Smartphones and tablets carry just as much personal data as your computer, and unlike the cellphones of yore, the new devices don't store all the data on SIM cards, which can be removed and destroyed. Unless you want your gadget's new owner browsing through your photos, Web history, text messages or contacts, you'll need to wipe it clean before selling.

This isn't hard to do as all the big mobile operating systems feature a factory reset option. For iOS devices, head to Settings, then General, and then Reset. Tap Erase All Content and Settings. On Android devices, the reset function is generally under the Privacy menu; for Windows Phone devices, look in the About menu. After a few seconds your smartphone will be void of any personal data.

Keep in mind that, when resetting Android and Windows devices, you'll want to remove any microSD cards (if your device supports them) before selling the phone, since a factory reset doesn't touch removable storage.

APP EVAPORATION

Q I've downloaded an app for my iPad that Apple has since removed from the App Store. Am I going to lose this the next time I update iOS?

A It depends on who yanked the app and how you've backed it up. According to Apple, if a developer pulls its app from the App Store or stops supporting it, then that app will be restored to your iPad or iPhone after you do an OS update. Your purchase will be stored in Apple's iCloud service and, after the update, your iOS device will restore and you'll get the last version of the app before the developer retracted it. If, on the other hand, the app was removed because of a violation of Apple's App Store guidelines, then it will, indeed, disappear when you update iOS.

But it doesn't have to. If you back up your iOS device to your computer via USB, those apps are stored locally on your computer. Apps are files like any other files (if you'd like to reveal their location, you can right-click on any app in iTunes and select Open Folder in Windows or Show in Finder on a Mac). If you back them up to an external drive, you can always just drag



Illustration by Steve Scott

your apps back into iTunes after an iOS update, then sync your device and get your lost app back.

If Apple removed an app that you paid money for and you didn't back it up, the company will usually make you whole again if you submit a claim through iTunes customer service. So don't be bashful about asking for cash back.

ROUTE AROUND A ROUTER

Q I recently switched Internet providers and they gave me a modem with a built-in 802.11b/g Wi-Fi router with one antenna. The thing is, I already have an 802.11n router with three antennas that gives better reception. Is there any way to disable the router from my ISP and use my own?

A You can't entirely replace your ISP's router-modem combo, but you can shut down its wireless functionality and use your own router instead. The reason your router is better isn't just reception; it can actually send data faster. Wi-Fi comes in many flavours, and the 802.11 spec tells you a lot about its abilities. Routers using 802.11 a/b/g are using older, slower technology; 802.11n routers are up to six times faster.

To shut down the ISP's router function, first turn off wireless on your computer and plug into your ISP's device directly with an Ethernet cable. Look on the ISP's modem/router for its IP address – usually something like 192.168.1.1 – then type that into a browser on your computer and bring up the ISP device's local Web page. The interfaces between machines vary, but look for a setting that says Turn Off Wireless. Then unplug your computer, hook up your router via the same Ethernet connection, and set it up normally. Finally, turn your computer's Wi-Fi back on again and log in to the network created by your own router. You should be all set.



JEFF PEDERSON,
manager of data
recovery operations,
Kroll Ontrack

ADVICE
FROM AN
EXPERT

WHAT TO DO IF A FLOOD DESTROYS YOUR HARD DRIVE

A wall of rain and water can destroy a home – and your computer, even your backup drive. If you want your data back, you're going to need a pro. Here's what he needs you to know so that he can do his job.

DON'T PLUG IN THE DRIVE. Don't test it or try to see if it's going to work. You'll only do more damage.

PUT IT IN A PLASTIC BAG WITH A DAMP PAPER TOWEL. It may seem counterintuitive, but keeping the drive moist may prevent the read/write heads from sticking to the media.

CHECK YOUR INSURANCE POLICY. Data recovery for a flooded drive can cost R20 000, but some policies have riders that cover data recovery.

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A SHARPER EDGE

Motorola Razr Maxx

Think thin, think Kevlar, think big screen and even bigger performance. Oh, and a very sharp brain. That's Motorola's new gem in a nutshell. Actually, not: there's so much more to this handset that potential buyers may find it a little bewildering. So, while we're waiting for the upgrade to Android's long-touted Ice Cream Sandwich, let's take a look at some of the features that revved our techie engines.

First up: something called Smart Actions, an app that monitors and remembers your mobile phone habits, then takes over (check it out at <http://bit.ly/1BT75>). This may sound a bit creepy but it seems to work. For example, if you habitually mute the ringer during office hours or tweak your Bluetooth settings at home, it will take over these minor chores with nary a complaint, leaving you free to exchange gossip around the water cooler (at work) or drink beer (at home, we'll assume).

Motorola claim their phone allows you to chat for twice as long as you can on the leading competitor's smartphone. There's no way we were about to test this (would you be prepared to host a 17-hour conference call or watch 15 hours of uninterrupted video?), so we'll just have to take their word for it. Here's where it gets weird (but in a good way): apparently the same Smart Actions battery optimisation settings enable you to push talk time even further. We'd be inclined to use the app for something more useful, such as shutting off the sync functions while you're asleep.

Not surprisingly, the Razr Maxx comes with excellent specs:

- a fast (1,2 GHz) dual-core processor
- 1 GB of RAM
- a Super AMOLED 4,3-inch HD display
- a scratch-resistant Gorilla Glass screen
- Kevlar bodywork
- "government-grade" security to protect your e-mail, contacts and calendar.

You get all the features of the original Razr, but this one comes with a non-removable battery (whence that extra life; we managed two full days with moderate usage) plus a better (8 megapixel) camera.

Nice one, Motorola.



EASY RIDER

BMW G 650 GS Sertão

This bike takes its name from the eponymous badlands of northeastern Brazil – a dry and unforgiving place that tourists tend not to visit and where the locals, like the thorn bushes that comprise much of the indigenous *caatinga* vegetation, are known for their toughness.

It fits, as does the bike's previous name – Dakar (the Sertão may have a few desirable tweaks, but it's essentially the same machine as its

popular predecessor). Not that this is a bad thing: it remains a thoroughly likable motorcycle... powerful, agile, easy to ride, and able to go virtually wherever you point it. What makes it *really* appealing is its ability to perform equally well on rugged off-road expeditions and daily urban commutes.

Power is provided by a water-cooled, single-cylinder 4-stroke engine producing a relatively modest



35 kW at 6 500 r/min and 60 N.m of torque at 5 000 r/min. Although these are not the sort of stats one associates with neck-snapping acceleration, it's more than enough to take you places at a useful turn of speed – and quite frankly, some of us have reached the point where balls-to-the-wall riding seems too much like hard work.

Fully fuelled, the Sertão weighs 193 kg, which makes it easy to

throw the bike around – and throw it we did. We thought the seat height was just right (it's an accessible 860 mm off the ground), we liked the near-upright riding position, which makes for comfortable long-distance travel, and we appreciated the fact that the setup is slightly skewed towards off-roading. After all, if you wanted a pure road bike, you'd buy one.

The bike comes standard with

BMW's proprietary two-channel anti-lock braking system (which can be switched off; we did), wire spoke wheels, and the undeniable street cred associated with BMW's stylish GS range. We have a sneaky feeling that it's pretending to be bigger than it is, but hey, is that such a bad thing? If you'd like one, be prepared to cough up R90 884.

● Look out for our BMW K1600 GTL riding impression next month. PM

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Out there

Getting wet in the interests of fun and freedom

Now that summer is looming (and none too soon), it's time to haul out your powerboat, dust off the camping gear and prepare to explore new opportunities for fun in the great outdoors. A new outboard might not be a bad idea... or perhaps a paper cooking pot?

THRIFTY PERFORMER *Honda BF250 outboard*

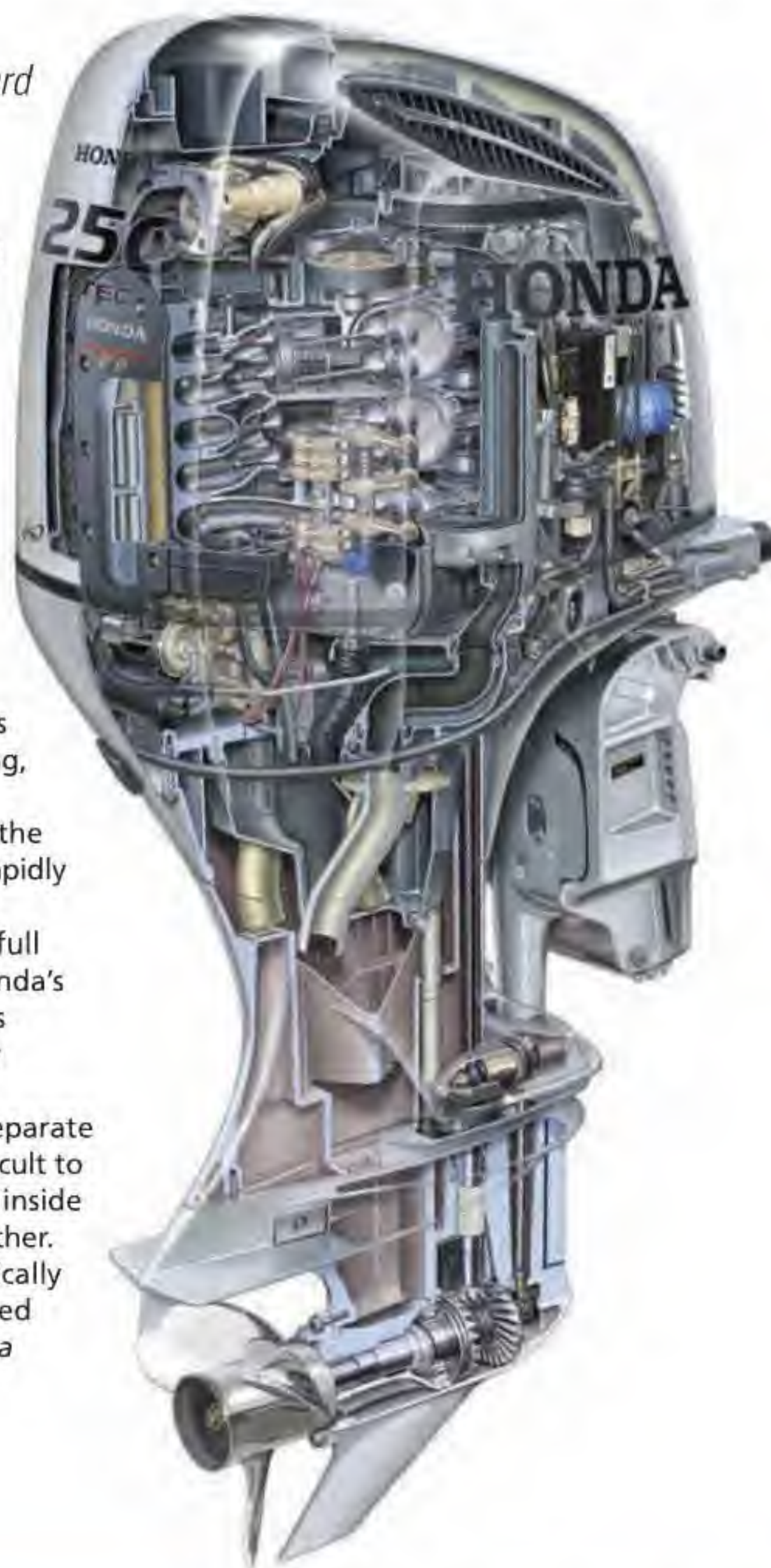
If you thought sailing was an expensive pastime, try powerboating. Heading offshore with two hefty outboards strapped to your transom for a bit of fishing fun can easily saddle you with a R6 000 fuel bill – a whopping sum, considering there's a good chance you may not catch a thing on the day.

Now for some good news: Honda Marine's latest flagship outboard, the 3,6-litre V6 BF250, not only boasts impressive fuel economy, but also delivers the blistering hole-shot capability found in two-stroke engines. To make this possible, the boffins at Honda incorporated some pretty cool tech.

First off – their second-generation lean-burn control system. Controlled by the ECU and based on feedback from the oxygen sensor, it improves fuel economy by accurately managing the air/fuel ratio in real time, no matter where you place the throttle. For those rapid starts required for activities such as surf launches or wakeboarding, there's their boosted low speed torque (BLAST) system. Activated by quick movements of the throttle, it enriches the air/fuel ratio and aggressively advances the ignition curve, rapidly increasing torque to get your hull up on the plane faster.

Because many offshore boaters undertake long runs at full throttle, durability is entirely relevant. To address this, Honda's gurus applied their minds to the gear wheel, increasing its diameter by 10 per cent, increasing the tooth thickness by 38 per cent and reducing the face pressure by 9 per cent.

A direct air intake system incorporating a chamber to separate the cool outside air from water (something that proved difficult to achieve in the past) prevents air temperatures from rising inside the engine, thereby boosting the available power even further. It also features an adjustable charge system that automatically raises the engine's revs when heavy power loads are applied while at idle. For more information, visit www.honda.co.za



YOU'RE GOING DOWN *iGills smart dive computer*

If you're an undersea explorer of the connected variety, it's likely that you own a smartphone, and possibly an iPhone. In this case, you'll be very interested in the iGills SE-35, a distinctly clever device that works with your handset to provide advanced dive computer functionality with an easy-to-use interface. iGills offers ascent rate indication, nitrogen load tracking over multiple dives, low time and depth alarms, altitude compensation and more, with multiple diving modes (including Air, Nitrox and Gauge) adding to its versatility.

As you navigate to other screens to capture pictures or video, the most relevant dive parameters – such as depth and time remaining – go with you. In essence, all your critical information is always in view. Having determined your location, the iGills automatically generates a content-rich dive log. When you hit the water, it creates a dive event, stores your depth profile throughout the dive, and links pictures and videos captured to the dive event.

Back at the surface, all of your dives are organised and accessed with a screen touch. Media generated with iGills can be synced through iCloud, posted on Facebook or e-mailed directly from your phone. Slide in your iPhone3S and you have a digital magnetic compass. Slide in your iPhone 4 or 4S and it's even gyro-stabilised.

Works for us.



CALLING ALL FLAT-PACK FOODIES *Hexapot*

Imagine this: you're packing your rucksack in preparation for a long hike, but once you've squeezed in your sleeping bag, camping stove, three changes of clothes, dehydrated food and a few other essentials, you find there's no room left for a cooking pot. No problem – just slip in a paper Hexapot, and you're away.

Hold on... a cooking pot made from paper? That's exactly the reaction that US company Energia got when they introduced their revolutionary outdoor product. Made from pre-folded waterproof paper, it's sold as a flat package and opens out into its three-dimensional pot form with minimal fuss, allowing you to cook all manner of interesting stuff for your hiking companions (if you're unable to work out why the pot doesn't catch alight, be aware that the explanation has more to do with science than magic).

Each pot can be used two or three times before disposed of in an environmentally sensible manner (they're biodegradable, reportedly dissolving into harmless mush within 2-3 years). According to Energia, the design of the Hexapot is based on "traditional principles of origami", using a single sheet of multi-ply paper. No adhesives are used, and the shape is locked by folding. At the time of going to press, the company was arranging to sell its paper pots through Amazon.

PM







18 ways to save fuel

For every few cents that fuel prices go up, South Africans spend zillions more each year at the pump. No one wants to waste that kind of money. So unless you're (a) in the habit of carting the whole school rugby team to their next practice, or (b) living on a generous trust fund, **[1] IT MAY BE TIME TO UNLOAD THAT OLD GAS-GUZZLER.** Yes, we know you enjoy the feeling of power that comes with an elevated driving position, but when you weigh it up against penury, does that level of superiority really matter? Rhetoric aside, you might benefit from these practical fuel-saving tips...

> BY MICHAEL FRANK



If you're driving something that gets reasonable fuel economy, drive it reasonably. When entering a highway, **[2] accelerate to 120 km/h at about double your car's top 0-to-100 time** (if you don't know this, consult your copy of CAR magazine). As POPULAR MECHANICS proved in a battery of tests, this puts your vehicle in its more efficient top gear quicker than the smug hybrid crawling up to speed... in the left lane (*snort!*).

[3] Coast – in gear. The same tests showed that rolling in neu-

tral requires a trickle of petrol to keep the engine running, whereas in-gear coasting does not – and that if you anticipate traffic lights and **[4] don't come to a complete stop**, you can improve fuel efficiency by as much as 50 per cent.

A warm engine is more efficient, so string errands together by **[5] driving to the furthest destination first**, which will get the block heated up, then work your way home.

When it's warm out, keep cool by opening the windows, enjoying the breeze, and **[6] turning off the fuel-hungry air-con.** At highway speeds, however, our tests showed that windows-down driving creates drag. So at 120 km/h (or faster!), roll up the windows and **[7] put on the air-con.**

Notice to hoarders: You don't need to lug around a case of oil, a bag of sand or that box of

antique tools you got at the garage sale, right? So **[8] empty the boot** – less weight, equals better mileage. Bakkie drivers, **[9] remove that 150 kg toolbox from the load bed**, and while you're at it, **[10] close the tailgate** to create a drag-reducing air bubble. The MythBusters managed to increase the overall range of a full tank by nearly 50 km using this technique.

Interestingly, the show also proved that **[11] a right-turn-only route** (why on earth they don't introduce a left-turn version in South Africa is beyond us) boosts fuel economy by 3 per cent, because idling (at traffic lights, for instance) wastes fuel. For that same reason, **[12] avoid traffic pinch points.** Driving at speed is more fuel-efficient than creeping along in low gear. And if you're not regularly carrying a bike or a kayak on that roof rack, reduce drag by **[13] sliding off the crossbars** or at least **[14] sliding the crossbars all the way back** (making a single wing).

At the service station, **[15] inflate your tyres properly** and check them for uneven wear, which works against you. Stickier, wider performance tyres also increase road friction and sap mileage. So **[16] steer clear of tyres meant for race cars** yes, you know who you are). Also, **[17] get a tune-up;** a smooth-running engine is more efficient.

Finally, don't overlook the obvious: nothing saves fuel like not driving at all. **[18] Ride your bicycle** to fetch that litre of milk, especially if the store is just a kilometre or so away. **PM**

Illustration by Fuzzco

Gauteng

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Just wear it

CARRYING TECH IS SO LAST MILLENNIUM. NOW, INCREASINGLY, WE CAN SIMPLY SLIP INTO OUR DEVICES



Wristwatch GPS units, glasses that double as cameras and running shoes that track your workout are only the start. From a jacket able to sense airborne pollutants to a headband that can read your state of mind, wearable tech increasingly pushes the boundaries of how we interact with technologies. In fact, advances in apparel are such that soon we could even be talking about an additional category: tech-able wear.

Wearables have enormous potential for uses in health and fitness, navigation, social networking, commerce, and media, says Sarah Rotman Epps, a senior analyst serving consumer product strategy professionals at Forrester Research.

Technologies such as Near-Field Technology, which enables simple, seamless transfer of data between mobile phones – facilitating cashless payments, for instance – could be brought into devices as small as wristwatches or spectacles.

“Wearables will transform our lives in numerous ways, trivial and substantial, that we are just starting to imagine,” Epps says.

Advances in physical technologies and hardware (miniaturisation, battery life and smarter sensors are obvious exam-

Google Project Glass

Will we soon be viewing the world through Google-tinted spectacles? Google Developers are the only ones who might have an idea, given that the technology is exclusively available to them for pre-ordering (delivery next year) at a cost of \$1 500, including a prototype of the glasses and a software development setup. Current prototypes take the form of a pair of glasses incorporating a head-up display; us consumers have been told expect fully functional ones, possibly with a less intrusive look, by 2014.

Project Glass is Google’s augmented reality display project. Run on the company’s Android operating system, it would put smartphone functionality and interconnectivity on to our brows, allowing hands-free operation. It’s also envisaged that the device would use normal spoken voice commands, much like Apple’s Siri voice assistant.

ples) will help accelerate developments in wearable tech. But according to Epps, it will be the software platforms driving the hardware that hold the key to consumer adoption.

"In the same way that Windows took the PC mainstream and iOS and Android are powering the smartphone revolution today, wearables' success depends on backing from one or more of the big five software platforms: Apple, Google, Microsoft, Amazon and Facebook. These platforms – and their developer communities – hold the key to the consumer connection."

Apple's polished marketing, hardware manufacturing and development machine will drive development of "app-cessories". Google's open-platform Android provides both the freedom to dabble and the security of a huge developer corps. Its vast search infrastructure and access to information such as location-based data could be the basis for many wearable device features.

Windows Embedded, Microsoft's operating system and related solutions for "intelligent systems", powers a wide range of products from Ford's Sync vehicle information system to Polycom conference phones. Admittedly, these are aimed at big enterprise users; but Microsoft's Kinect for Xbox 360 is gaining traction with developers as an interface and could help drive the company's offerings towards the consumer mainstream.

Amazon's information on more than 100 million products and their buyers would be an asset in wearables. Similarly, Facebook has access to 800 million people and facial recognition software, to boot.

Epps predicts that in just three years wearables will be a seriously hot topic. The march towards the mainstream will occur in three phases:

- * Apple grows the app-cessory market with a deeper investment in wearables, by adding more sensors, connectivity and features such as voice control.
- * Google broadens wearable experimentation with its open platform.
- * Microsoft competes with an "anti-platform" platform. With Windows 8, Microsoft is pivoting away from .NET/Silverlight to the open Web protocols of HTML5 and Javascript. This shift will be a strength for Microsoft to build on, promoting a future OS for wearables as a more flexible, scalable platform for developers than iOS or Android.

While we're waiting for that to happen, check out some wearables that are already available – and a few that are not far off.



XWave Sport

It looks like any other headband, but built into the washable sweat-absorbent fabric of the XWave is a brainwave detector. This incorporates a Bluetooth module and a removable medical-grade brainwave detection unit that interfaces with the user via a conductive strip. The point? It provides information about your state of mind. Hey, training is not just about muscles and lung capacity: parameters such as relaxation and focus levels are measured. These can be sent to Bluetooth-compatible devices for storage and analysis.

Positioned over the left eyebrow, the detector in the XWave Sport is able to measure the brain's electrical impulses. According to the manufacturer, PLX Devices of California, a patent pending magnetic clip that attaches to an ear will ground the device for better reception.

Price: in the USA, about R850.

Fabric energy storage

A concept developed at the University of Southern California has the potential to overcome the serious limiting factor of our inability to make batteries both small and powerful with today's battery technology. Although the idea is not new, the University of South Carolina take on it is cheaper and more planet-friendly than previous efforts.

Xiaodong Li, above, a professor at USC, sees a future where electronics are part of our wardrobe. To prove his point, he and his team transformed a cheap T-shirt into a source of electrical power. Soaked first in a solution of fluoride, it was dried and baked at high temperature in an oxygen-poor environment to prevent charring or burning. The surfaces of the resulting fibres in the fabric were shown by infrared spectroscopy to have been converted from cellulose to activated carbon. Yet the material retained flexibility.

Connected to an electrical circuit, the material was able to act as a capacitor to store current. Coating individual fibres in the activated carbon textile with "nanoflowers" of manganese oxide, just a nanometre thick, enhanced the effect to create a "supercapacitor" with extremely high storage capacity. Stacking these would allow charging of portable devices such as cellphones. "We will soon see roll-up cellphones and laptop computers on the market," Li says. "But a flexible energy storage device is needed to make this possible."



Mobile Music Touch

What started out as a way of speeding up the process of learning a musical instrument is showing promise as a form of therapy that may improve sensation and motor skills for people with paralysing spinal cord injury (SCI). Georgia Tech researchers have created a wireless, musical glove called Mobile Music Touch (MMT). Looking rather like a workout glove with a small box on the back, MMT is used with a piano keyboard and vibrates a person's fingers to indicate which keys to play. While learning to play the instrument, several people with SCI experienced improved sensation in their fingers.

Researchers recently completed a study focusing on people with weakness and sensory loss due to SCI. Said PhD graduate Tanya Markow, the project's leader: "(We) were surprised by how much improvement they made in our study. For example, after using the glove, some participants were able to feel the texture of their bed sheets and clothes for the first time since their injury."

The MMT system works with a computer, MP3 player or smartphone. A song is programmed into a device, which is wirelessly linked to the glove. As the musical notes are illuminated on the correct keys on the piano keyboard, the gadget sends vibrations to "tap" the corresponding fingers. The participants play along, gradually memorising the keys and learning additional songs.

However, these active learning sessions with MMT were not the primary focus of the study. The participants also wore the glove at home for two hours a day, five days a week, feeling only the vibration (and not playing the piano). Previous studies showed that wearing the MMT system passively in this manner helped participants learn songs faster and retain them better. The researchers hoped that the passive wearing of the device would



Sony Entertainment Access Glasses

Special glasses from Sony allow deaf and hard of hearing viewers to see subtitles in their direct line of sight for both 2D and 3D movies, as well as audio for the blind, in suitably equipped cinemas.

The line-of-sight subtitling means there is no need to shift focus between the auditorium screen and a separate display unit. The key ingredient consists of lightweight glasses that are similar in size to many 3D glasses in use today. Weighing around 80 grams, the glasses can be programmed to display bright closed caption text in a choice of six languages. The location of the text can be easily adjusted, allowing moviegoers to follow along without having to avert their gaze from the screen or be irritated by obstructions. A clip-on filter enables 3D viewing while avoiding any blurriness.

also have rehabilitative effects. At the end of the study, participants performed a variety of common grasping and sensation tests to measure their improvement. Those who used the MMT system performed significantly better than those who just learned the piano normally.

Markow believes the increased motor abilities could be caused by renewed brain activity that sometimes becomes dormant in persons with SCI. The vibration might be triggering activity in the hand's sensory cortex, which leads to firing in the brain's motor cortex.

Necomimi

With Necomimi, there's no need to speak your mind: your ears do all the talking for you. Gamers and, lately, active types (see XWave) have experienced brainwave-detecting technology from NeuroSky. Up to now, the company's brain-computer interface (BCI) technology features in various fairly serious devices, but the latest is a little off the wall.

Necomimi, from Japanese fashion electronics company Neurowear, is a pair of brain-activated fluffy cat ears that reflect your state of mind. An EEG sensor located on the user's head picks up the brain's electrical impulses.

According to Neurowear, the device employs research-grade technology used by over 400 universities. From the sublime to the ridiculous: the two sensors (one on the forehead, another on an ear) are able to detect three basic emotional states. A state of alertness pricks up the ears; relaxation causes them to droop; and if you are "in the zone" - relaxed and focused - they wiggle. Presumably your friends respond accordingly.

They're on sale in the USA at about R850.

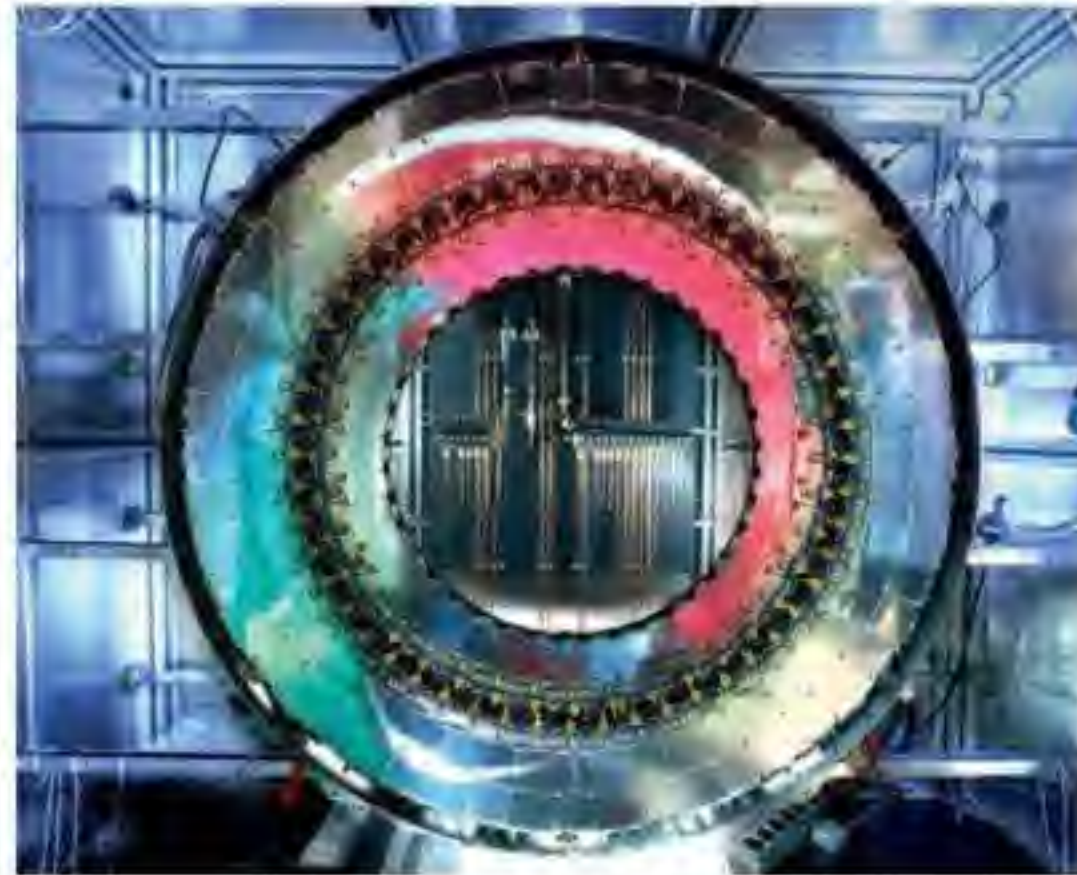
PM





DO YOU UNDERSTAND THE HIGGS?

Naturally, you're aware that a new particle was recently observed at CERN's Large Hadron Collider. Physicists are ecstatic, having identified it with near-as-dammit certainty as the long-sought Higgs boson, the missing piece in the Standard Model of particle physics. If you still feel a little under-informed, listen to theoretical physicist John Ellis as he answers the question, "What is the Higgs boson?", in a video on www.popularmechanics.co.za



rAge EXPO 2012

Don't miss the **2012 rAge expo**, taking place from 5-7 October at the Coca-Cola Dome in Johannesburg. You'll get to play the latest games and touch the latest toys and gadgets while chatting to local experts in the field.

rAge (short for **really Awesome gaming event**) celebrates its **10th birthday** this year. Coincidentally, so does POPULAR MECHANICS. To celebrate, we're giving you the chance to **win 1 of 8 sets of family tickets** [two adults and two children per set], each worth **R180**, for rAge 2012. To enter, visit www.popularmechanics.co.za. The competition closes at midnight on 16 September.



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DIY HOME

> BY ROY BERENDSOHN



LOCKDOWN

Q We own a holiday cottage, and for the first time we've had repeated break-ins and some theft. To increase security, I was thinking of chaining a few valuables down. Is there a chain that can't be cut with bolt cutters?

A The short answer is yes, you can get cut-resistant chain (shown left). It's hardened throughout its thickness, and its flat face distributes the force of the bolt cutter's jaw over a wide area, thereby diffusing it. There are also industrial high-strength welded steel chains that are through-hardened. The larger diameters of these chains, especially the 16-, 20- and 22-mm sizes, are extremely difficult to cut due to their girth and hardness. (Note I say difficult, not impossible; there are industrial bolt cutters that have jaw sizes as large as 20 mm and are designed to cut hardened steel.)

Industrial chain is rated by grades; the higher the grade number, the more steel alloying elements it contains and the more resistant it is to the variety of loads a chain encounters, especially in tension. Grades 70, 80 and 100 are among the hardest and toughest available. Here's the kicker, though. We're talking expensive: chain that costs R500 to R1 000 per metre; it's likely to be more valuable than what you're chaining down, a fact that might not be lost on an enterprising thief, who might just make off with the chain itself!

Regardless of how strong the chain is, you'd also need a cut-resistant padlock, such as a shrouded model. You might also have to attach the chain to something secure, such as a concrete footing. Likewise, hasps, bars and bolts have to be thick and impregnable. It doesn't take much to deter a lazy thief, but it takes a lot to keep out one who's determined to get in, if for no other reason than to prove his point. Any weak link (if you'll excuse the pun) invites trouble in the form of a bolt cutter, an oversized crowbar or – don't laugh – a chain hooked to a large pick-up. I had a neighbour whose home was

burgled by a thief who used the rear bumper of his pick-up as a battering ram, which he put through the front door.

I might be stating the obvious here, but holiday house owners have relied on some pretty low-tech security measures over the years. First, make friends with local families and fellow owners. In all but a few communities, people look out for one another. Next, don't store anything in the house or an outbuilding that you'd be afraid to lose. Keep power tools, chain saws, outboard motors or other gear elsewhere. There may be a local business that can store equipment for you for a fee, or a nearby storage facility. Sure, stopping on the way to the house is a nuisance, but so is having your property stolen.

Finally, alert the local authorities when you're away. Some rural police departments have added four-wheel-drive vehicles and ATVs to their fleet, making it possible for them to patrol remote areas.

CRACKS: WHEN TO WORRY

Q We have a crack in the foundation wall of our log cabin. Do we need to be concerned about it structurally? And could termites enter through it?

A Put it this way: a crack doesn't have to create structural troubles for it to be a problem. Cracks are ugly, suspicious things that aren't easy to fix, and even one that's no more than a hairline could grow and create all kinds of difficulties.

I would say any crack wider than 2 mm is a problem, especially if it admits water or increases in width or length, or if its faces grind against each other with changes in temperature and humidity. All of these indicate foundation movement, and that's not good.

As for termites, those pests can slip through a crack that's half a millimetre wide. If you live in an area where termites are common, have your home inspected by a licensed pest-control contractor.

The good news is that in most cases only large cracks indicate structural trouble. You'll need to contact a structural engineer or foundation repair company in certain cases, such as if the crack wraps around a corner or if there's a horizontal crack with a sagging wall underneath. Both of these indicate that the soil supporting the foundation is moving (horizontally or vertically) and taking the foundation with it.

It's tough to fix a crack. It's one thing to simply fill it with epoxy and hope that it holds. It's a much larger matter to evaluate the foundation inside and out and deter-

mine what's causing the crack, undertake those repairs, and then seal the crack shut for good. That kind of repair is expensive and often involves reducing the hydraulic forces acting on the foundation by installing drainage pipes, gravel, filter fabric, a sump pit and a pump. In the worst cases, the foundation may need additional support from piers driven next to it. It takes an experienced foundation repair company to do that work.

If you're going to attempt a DIY repair, do your homework. A number of sites offer small-scale versions of epoxy injection kits used by contractors, and you can still buy tried-and-true cement-based products to carry out repairs.

ADIRONDACK OPTIONS

Q I've checked out cedar Adirondack chair plans online and would like to know what other kinds of wood I can use to build my own chairs.

A The nice thing about Adirondack chairs is that you can build them out of nearly any wood. Meranti and balau are easy to work with and highly weather-resistant, especially if stained or coated with a clear preservative. I've even seen these chairs built out of pine. With pine, though, you should pre-treat the wood with a paintable water-repellent preservative that also provides protection against wood-boring insects. And when using pine, be particularly careful to soak

the end grain to reduce the chairs' tendency to wick moisture from the ground or a wet surface. I'd follow the pre-treatment with a quality alkyd primer and topcoat paint or an exterior alkyd wood stain.

Another option is pressure-treated timber. With that material, you wind up with a chunky, timberyard look that some people really like. Let the wood dry thoroughly before using the chairs, to avoid any chance of skin irritation from the treatment chemicals (especially important with kids).

You should use hot-dipped galvanised or stainless-steel fasteners with any outdoor woodworking project, but they're essential with pressure-treated timber, which aggressively attacks steel fasteners, causing them to corrode.

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Slipping new glass into place is a delicate dance. Tip the skinny end in first and rotate the panel until it catches in the window track. Test the fit by sliding it up and down by hand.

GLASS WARFARE

Petty car theft often means broken side glass. Repairing the damage yourself is one way to ease the loss.

DEGREE OF DIFFICULTY **4/10**

You get a pretty nasty knot in your stomach when you discover your vehicle's side window has been smashed and the interior ransacked; ask me how I know. On top of whatever was taken, there's the added injury of getting the car repaired. Between the time it requires to file a claim with the insurance company and the inconvenience of taking the car to the repairers, fixing the window yourself can sometimes save a lot of headaches. Professional glass repair,

including new glass and labour, has a frustrating tendency to cost exactly a few rand less than an insurance excess, so doing it yourself can save a ton of money. With a few pointers and some savvy parts sourcing, that unprotected hole in the door can be fixed in no time.

CLEAN UP

Unlike plate glass, vehicle glass is tempered, or heat treated, so it's very hard, but when stressed past its breaking point it fails

uniformly and catastrophically. This results in small pieces that won't cause grievous harm to passengers, but the debris gets everywhere and will result in tiny, annoying cuts. Grab a powerful workshop vacuum and clean the seats, doors, dash, carpet, and centre console. Do the entire interior even if it doesn't seem necessary; glass will be in places that don't make any sense. Safety glasses and good work gloves are a must.

GETTING PARTS

If you drive a luxury car with acoustic panes and special coatings, new glass is crazy expensive and hard to find. Mass-market cars have more affordable and readily available parts. Most car dealers will refer you to a glass specialist for brand-new parts, but if you can locate used glass, the savings can be significant. Hunt through nearby junkyards to find parts for common vehicles at steep discounts. For my 2001 Ford pick-up, used glass cost 11 per cent of a new piece.

BEHIND DOOR No 1

The basic steps for replacing door glass are common, but the devil is in the details. The inner door panel comes off, the mounting hardware holding on to broken shards must be extracted, and new glass has to be shimmed into place; then everything's got to be bolted back together. My vehicle is very basic – power nothing with roll-up windows – but as cars get more complicated, inner door panels get more devious in design. Grab a service manual for your car to make the process much clearer. This door panel on my vehicle is one big piece of plastic hung on retainer hooks, held tight by a few screws hidden behind trim. Yours will definitely be a harder repair, with multiple layered components and finicky clips.

If you have power windows, and most late-model cars do, you'll need to unhook the quick-disconnect plug that delivers power to and from the window switches mounted to the inner door panel.

REMOVE AND REPLACE

With the inner door panel removed, peel back the plastic vapour-barrier sheet carefully, as you will need to reinstall it later. You should be able to see the door's innards. Raise or lower the window-height-regulator mechanism to its service position; the height where the bolts or screws holding the glass remnants to the regulator align with access holes stamped in the steel. Crank windows make this easy; on



1 →



3 ←



4



(1) To remove the inner door panel, look for nuts and bolts hidden behind trim. (2) The door panel is usually one big piece with components such as armrests bolted on. (3) Loosen the screws on the regulator to free the leftovers. (4) Pull the lower window seal, making a wider slot to slide the new panel in.

power windows, plug in the switches on the loose inner door panel and turn the ignition to the "on" position; operate the window until the bolts align with the access holes. Vacuum broken glass from the door cavity; spending extra time here now avoids rattles later.

Next, remove the seal at the bottom of the window to open up the slot the glass panel needs to fit through. Finally, free one of the window tracks for fore-and-aft play that will make the install easier. These tracks guide the panel's path and are bolted along the bottom of the door.

Wriggling the new glass into place is tricky. Drop the shorter side in first at a near-90-degree angle and try to catch the long side of the glass in its track; then rotate the short side up. After a few tries the glass will slip into place. Attach the glass panel to the regulator (ask a friend for help) and bolt the window track down, then run the new glass up and down to ensure that the motion is satisfactory. The remainder of the work: put the door together in reverse order. Hopefully you took good photos. **PM**

QUICK TIPS

→ Interior designers work hard to hide the screws and clips holding the door together, so peep under and behind places you wouldn't normally look.

→ Tools you'll need include screwdrivers and a socket set, but a trim-removal tool will help a lot. It makes popping off clips and retainers much easier than with a screwdriver.

→ Since we're dealing with glass, wear a heavy long-sleeve shirt, full pants, covered shoes, gloves and safety glasses. Tempered glass is safer than plate, but still treat it with respect.

→ When handling glass, be very methodical and don't force anything. If getting something to fit is too hard, you're not doing it right. Step back and examine the situation again.

→ Take pictures in sequence to remember how everything goes together. Keep removed parts in a cup or on a tray so they don't get lost.



The Chevy Volt's T-shaped battery pack includes more than 200 lithium-ion cells, a coolant-circulation system, and electronics. It also acts as a structural element.

VOLT VINDICATED

I'm interested in the potential of extended-range vehicles such as the Chevy Volt, but the news stories about battery fires have freaked me out. Can you supply a definitive answer about what's going on?

A Of the 15 054 Chevy Volts sold as of this printing, exactly zero have caught fire out in the real world. I don't want to sound like a cheerleader for the Volt programme, but it pushed a lot of boundaries in engineering and testing and in some ways exceeded the standard testing parameters the US National Highway Traffic Safety Administration (NHTSA) uses.

All the hubbub revolves around one particularly strenuous crash test – the side pole test – done in May 2011. In this series of tests, a car is run sideways into an immovable steel post at 20 mph (32 km/h), then it's rolled 90 degrees on to its side and all the fluids are allowed to leak for 5 minutes. The car is then rolled on to its roof for 5 minutes and

then on to its other side. The test looks for side intrusion into the cabin and damage or danger caused by the loss of car fluids.

NHTSA's Volt passed these tests and was parked in an outside storage area. A strange thing happened: after three weeks, the battery caught fire, consuming the already wrecked vehicle and a few cars nearby.

I spoke to Doug Parks, GM's global vehicle chief engineer for the Volt, who started off by saying, "I believe the Volt has always been safe, but this was an event we needed to investigate thoroughly." After some sleuthing, they found the source of the fire was a short circuit caused by something called dendritic growth. The phenomenon occurs when energised silicon chips get

wet and their metals are leached through the substrate, growing into what looks like tree roots that eventually lead to a short circuit.

The battery in the Volt is shaped like a capital T, with the top of the T under the rear seats and the remainder running up the centre tunnel between the front seats. During the test, the undercarriage crash structure successfully absorbed crash energy but also punctured the battery case and cooling system. When the car was rotated, coolant worked its way on to the top of the battery, where an important control module lives, and got its silicon chips wet. Because the testing standards at the time did not require the battery to be discharged after the crash (analogous to draining the fuel tank, which is standard practice), dendritic growth occurred and the chip short-circuited, connecting the poles of the battery and leading to a battery fire.

After repeated testing to replicate the scenario, GM found the probability of this happening in a real-life crash to be nearly zero, but took preventive action anyway. The area of the battery tunnel around the crash beam was reinforced, and a coolant-leak sensor was added as well. All new Volts built since February come with these upgrades, and older cars can be taken in to dealers for what GM

calls enhancements, since this isn't considered an official recall.

Parks also notes, "The major automakers including GM are now working with the Society of Automotive Engineers to standardise discharge methods following an impact event." I've paid close attention to this story, and after reviewing the testing, failure mode and response, I'm comfortable with the performance of the Volt in crash testing. As a final thought, consider this: traditional cars carry around 60 litres of highly flammable (and carcinogenic) petrol in an easily pierced tank under the car, yet you don't even think about it.

A DAY AT THE DRAGS

Q I have a 1986 Chevrolet Camaro that I want to take to the dragstrip occasionally. I'd like to put drag radials on the car. The original tyre size is 215/65R15, and the drag radials are 235/60R15. A little maths reveals that the drag tyres will rotate two fewer revolutions in a kilometre (480) than the stock tyres (482). I'd like to know how much this will affect my speedometer.

GLOSSARY

ETHYLENE GLYCOL

The main chemical in auto antifreeze. Its freezing point is only about 10 degrees lower than that of water, but when the two are mixed 50/50, they stay fluid to minus 30. Antifreeze contains anticorrosion additives. Check your owner's manual to find which brand plays nice with your engine.

A You've picked just about the perfect car for this kind of thing. Camaros and Mustangs were practically built for the strip, and aftermarket parts are so plentiful you can almost build the car from scratch. Your choice to go with drag radials for racing is a wise one; these tyres have much better grip than standard tyres, owing to a softer rubber compound. Great for racing, bad for daily driving.

The drag radials are slightly larger in diameter, which will have a tiny effect on the accuracy of your speedometer, and you've already done the hard calculations to figure out how much. The revolutions per kilometre of the drag tyres are a percentage of the original tyres' and thus will result in a speedometer reading lower by the same percentage.

How much? Divide the stocks' revs per kilometre (480) by those of the drag radials (482). That gets you to 1,0042, the amount to multiply to figure out the true speed.

For example, with the drag radials installed and the speedo reading 120 km/h, multiply by 1,0042 to get 120,504 km/h. The error at 120 km/h is a scant 0,504 km/h. Here's the catch to all of this: your speedometer isn't accurate anyway. Unless you're driving an ex-police-spec car with a calibrated speedometer, your factory speedo is off by as much as 5 per cent even when new. That's much more than the difference your new tyres will make. The takeaway? Just run it at the strip for fun and don't worry about the speedometer's accuracy; that's what the timing lights are for!

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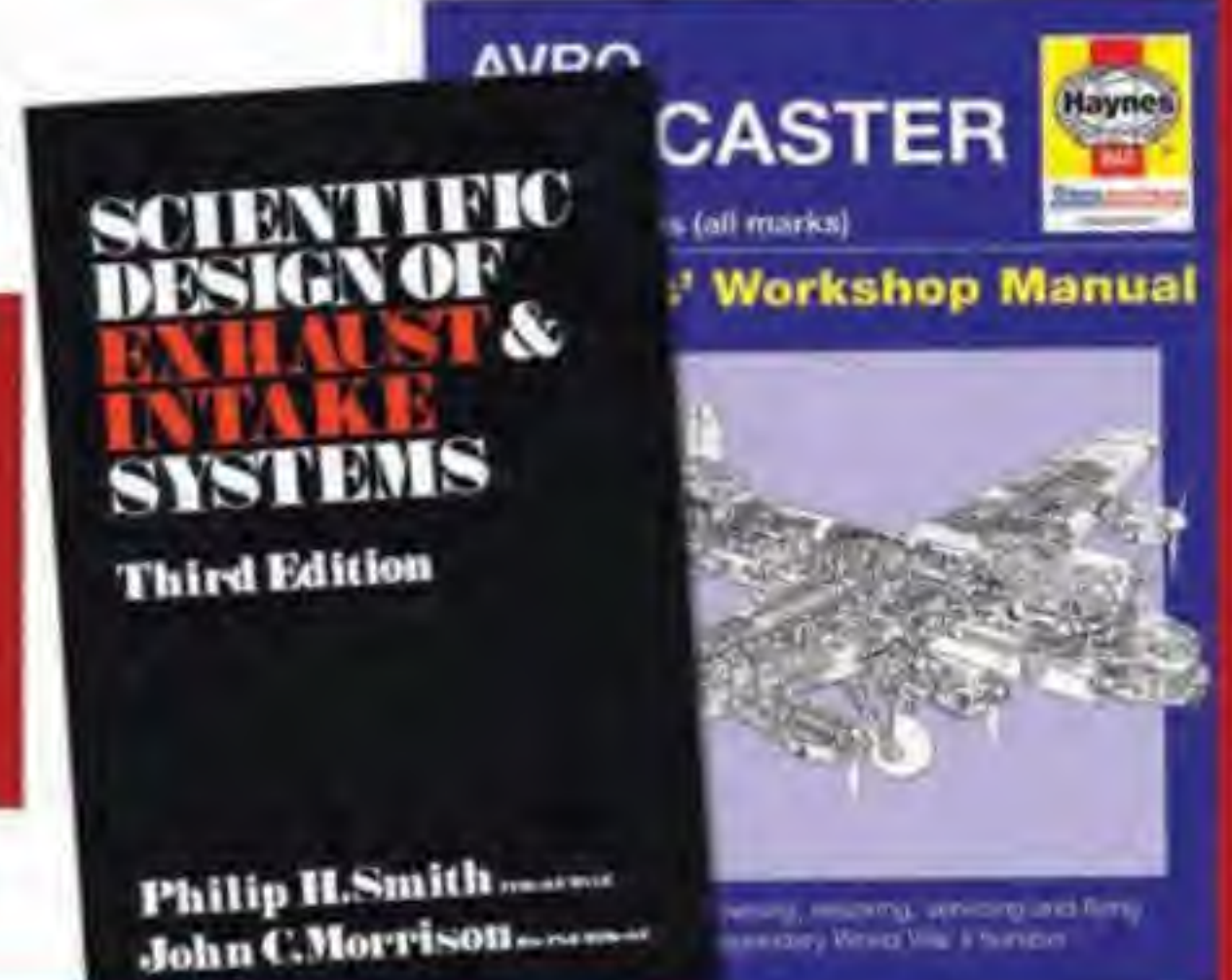
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Parrot AR.Drone 2.0

The AR.Drone was a fun toy when it arrived two years ago, but the new flyer promises an updated design and fresh features that put it much closer to the realm of your own personal spy drone. It is now stuffed with far more pro-level features and even offers a somewhat sleeker and, according to Parrot, more resilient design. Now available!



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WINNING TIP

SAVING MONEY AND WATER

After buying my first home last year, I was taken aback by the high running costs incurred by a normal household. Electricity being the main money drainer, I was happy to fall back on my back issues of PM for help on keeping these costs down. As we all know, the geyser is the main culprit, so I immediately set to work on proper insulation, turning the temperature down and switching it off when not in use.

This all contributed to a saving of about 20-25 per cent each month, but I thought I could do better without having to install expensive gadgets. I have two small children who cannot wait to climb into the bath each evening. To save hot water (and electricity), I place a large plastic basin inside the bath and add 15 litres of warm water; previously, their bathing ritual consumed 60 litres. The result is another 15 per cent off my electricity bill. This strategy also saves water: should my wife or I decide to take a bath afterwards, I simply empty the basin into the tub and top up as needed.



COLYN MURRAY
CERES

A sharper edge

When cutting veneered board with a table saw, the underside can end up very ragged as a result of the downward-travelling blade tearing or chipping the covering. This can be avoided by adopting a very simple strategy: first, lock the fence to the desired width setting. Next, lower

the saw blade until only about 3 mm or so projects above the table (the actual depth is unimportant, just so long as it's small, and much less than the thickness of the board) and run the board to be cut through the saw; this will produce a smooth-edged groove on the underside.

Now, raise the blade to a height greater

than the thickness of the board and repeat the cut without changing the width setting, cutting right through the material. Turn the board over, and you'll see that the underside is perfectly smooth, with no breakouts.

Caution: To do this on a table saw, you will first need to remove the riving knife (if there is one) and possibly the blade guard, leaving the blade exposed, so be very careful.

CHRIS GRAHAM
RANDBURG

Been there, done that

We picked up this idea from an online resource (Pinterest) and thought we would share it with PM's readers. If members of your family are inveterate travellers, erect an old-fashioned sign (simply a pole with planks nailed to it, arrowed at one end) pointing to all the places they've visited. We did this in our back garden, and the sign always triggers animated discussions with visitors. The countries' names are painted in cheerful colours, so the sign becomes something of a garden feature. So far, no one has accused us of showing off!

HEATHER MURRAY
LINKSFIELD



Keep it clean, people

Is your braai grid encrusted with baked-on fat from last summer? Try this: place a sheet of aluminium foil (shiny side down) on the grid and heat it for about half an hour, bending one corner of the foil upwards to allow air to circulate. This works much like a self-cleaning oven, effectively removing the old gunge and restoring your grid to almost-new condition.

L HARRIS
RANDBURG PM

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It always seems impossible until it is done – Nelson Mandela

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